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USSR Report

MATERIALS SCIENCE AND METALLURGY

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USSR REPORT

MATERIALS SCIENCE AND METALLURGY

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UDC 669.721'/856:621.785.78

BREAKUP OF SUPERSATURATED Mg-Pr SOLID SOLUTION

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 1, Jan-Feb 86 (manuscript received 26 Nov 84) pp 106-110

[Article by L. L. Rokhlin and I. Ye. Tarytina, Metallurgy Institute imeni A. A. Baykov, USSR Academy of Sciences]

[Abstract] A study of oversaturated Mg-Pr solid solution and its breakup during heat treatment was made, considering that the maximum solubility of praseodymium in magnesium is 1.7 wt.% (0.31 atom.%) at the eutectic temperature of 575°C and only approximately 0.01 wt.% (0.002 atom.%) at 200°C. An alloy with 2.3% Pr was produced by smelting 99.95% pure magnesium and 99.7% pure praseodymium in a steel crucible with VI2 flux (38-48% $MgCl_2$, 25-36% KCl, 15-20% CaF_2. 7-10% MgO, - 6% NaCl + $CaCl_2$) inside an electric furnace. The ingot was hot pressed by extrusion into a rod 10.5 mm in diameter, corresponding to 88% reduction. The rod was cut into segments and these were annealed at 550°C for 2 h in a salt bath of molten 50% KCl + 50% LiCl, which yielded a praseodymium-rich solid solution. Subsequent quenching in water at room temperature converted such a solid solution into a supersaturated one. The rod segments were then cut into pieces, to be aged at various temperatures over the 150-250°C range for various lengths of time up to 200 h. Examination of 0.5-0.6 mm thick slices under a JEM-200·10^{-4} μm electron microscope with 150 kV accelerating voltage revealed the tetragonal ϵ-crystal lattice characteristic of the equilibrium phase in the Mg-Pr-$Mg_{12}Pr$ system. Hardness measurements revealed a dependence on the aging time different for each aging temperature, maximum hardness being reached after 200 at 200°C and already after 0.5 h at 250°C with subsequent softening but not yet after 6 h at 150-175°C. These results indicate that breakup occurs in several stages, with different products obtained by aging at different temperatures. References 8: 6 Russian, 2 Western.

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COLD SHORTNESS OF Cr-Mn-Si STEELS WITH UNSTABLE-AUSTENITE STRUCTURE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 86 pp 31-35

[Article by M. A. Filippov, Ye. S. Studenok, and M. S. Khadyyev, Ural Polytechnic Institute]

[Abstract] Embrittlement of wear-resistent Cr-Mn steels with unstable-austenite structure was studied, such steels not being subject to martensite transformation during cooling down to -196°C but prone to martensite formation under strain at temperatures above 20°C. The behavior of plain 80Mn8Cr3 steel (0.81% C, 8.82% Mn, 2.84% Cr, 0.78% Si) was compared with that of its two modifications containing 1.43% Si and 3.44% Si respectively, addition of 2% Si having been found to improve the wear resistance in dry friction. Wrought bar specimens 13x13 mm² in cross-section were quenched from 1120°C in water and then mechanically tested in an MK-30 impact machine with a swinging pendulum. The fracture surfaces were examined under an electron microscope by the method of carbon replicas and metallographically, the amount of α-martensite after deformation being measured with an α-phase meter. All fractures were found to be transcrystallitic. The temperature dependence of toughness and of the martensite content produced by deformation has been established on the basis of the test data. Since it was not practically feasible to separate ductile and brittle fracture components, the embrittlement temperature was tentatively defined as the average between maximum-toughness and minumum-toughness temperatures. The toughness dropped appreciably, from 280 J/cm² for plain steel and from 190 J/cm² for both silicon steels to 2.5 J/cm² for all three steels, within a narrow temperature range below -100°C. The results indicate a buildup of deformation martensite inplain 80Mn8Cr3 steel during dynamic bending throughout the -196-(+150)°C temperature range, addtion of up to 3% Si raising the martensite formation temperature up to +200°C and increasing the α-martensite content as well. The effect of silicon on the grain size is ambiguous, a small addition (1.43% Si) causing the grain to become larger and a large addition (3.44% Si) causing the grain to remain smaller. It therefore is not advisable to add silicon to Cr-Mn steel when the latter is required to withstand impact and abrasion. References 13: 10 Russian, 3 Western (1 in Russian translation).

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CHARACTERISTICS OF BREAKUP OF SOLID SOLUTION IN CHROMIUM BRONZES DURING AGING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 86 pp 37-39

[Article by G. M. Fedorov, V. N. Fedorov, M. G. Khan, and A. T. Manuylov]

[Abstract] A study of BrCr07 bronze (0.66% Cr) was made concerning the breakup of its solid solution during isothermal aging at two widely different temperatures for a length of time ranging from 3.5 s to 4 h. Ingots of this bronze, produced in a vacuum induction furnace, were heated to 1050°C and quenched; then some were aged at 500°C in a 50% $NaNO_3$ + 50% KNO_3 salt bath and and some were aged at 800°C in a 50% NaC1+ 50 KC1 salt bath. For a determination of the internal friction and its dependence on the strain amplitude in cyclic torsion, specimens 1 mm in diameter and of 100 mm gage length were tested at room temperature on a torsion pendulum oscillating at a frequency of 2 Hz, such a determination at the aging temperature not being possible because of very fast phase transformations. The results of these tests after aging at 500°C reveal two ranges of internal friction after the incubation period. It first remains constant as the strain amplitude increases up to some threshold level, whereupon it increases fast as the strain amplitude increases further. The threshold becomes somewhat higher after longer aging time, but the initial constant internal friction first decreases to a minimum after 30 min aging and then again increases somewhat. Aging at 800°C results in an only small decrease of the initial constant internal friction. This trend of internal friction as function of aging time and strain amplitude, together with electrical resistivity measurements and as confirmed by examination under an electron microscope, corresponds to two stages of the breakup of the solid solution. Accordingly, aging at 500°C causes formation of a fine-disperse second phase throughout the grain volume except along the grain boundaries and aging at 800°C produces a coarse second phase along the grain boundaries primarily. References 7: 5 Russian, 2 Western (1 in Russian translation).

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CHANGES IN STRUCTURE AND PROPERTIES OF WELDED JOINTS ALONG STEAM PIPES MADE OF Cr-Mo-V STEEL DURING LONG PERIODS OF SERVICE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 86 pp 46-49

[Article by R. Ye. Mazel, M. M. Melamed, V. A. Lappa, and I. I. Talysheva, All-Union Scientific Research Institute of Heat Engineering imeni F. E. Dzerzhinskiy]

[Abstract] Welded joints along steam pipes made of 12Cr1MoV steel were studied for changes in structure and mechanical properties after a 120,000 h long service at a temperature of 565°C under a pressure of 13.7 MPa as well as after supplemental aging by thermal diffusion for 80,000 h at 565°C corresponding to 200,000 h at 545°C. The joints had been produced with TsL-20M electrodes and tempered at 730-750°C for 3 h so as to satisfy standard performance requirements. Structural examination under a JSM-2K electron microscope and phase analysis revealed large increases of the Cr content from 8.5% to 19% and the Mo content from 40% to 63% with an insignificant increase of the V content from 65% to 69% in the carbides in both welding seam and fusion zone after the first 120,000 h. In the carbides in the base metal, meanwhile, the Cr content increased from 18% to 35% remaining higher than in the carbides in the welding seam, but the Mo content and the V content increased from 28% to 50% and form 40% to 70%, respectively, thus both becoming almost the same as in the carbides in the welding seam. Subsequent thermal diffusion monotonically increased the V content as well as the Cr content and the Mo content in their carbides further. After the first 120,000 h at 565°C the principal carbides were found to be $(Cr,Mo)_{23}C_6$, VC, Fe_3C in the welded joints and Fe_3C, $(Cr,Mo)_{23}C_6$, VC with traces of Cr_7C_3 in the base metal. Extrapolation of tensile tests after 120,000 h to another 100,000 h yielded a strength of 63.5 MPa at 565°C and 78.5 MPa 545°C after 220,000 h. The life of these welded joints, according to estimates based on experimental data and graphical analysis, should be 250,000 h at a temperature of 570°C under a pressure of 49 MPa. Tests were also performed before and after 120,000 h at 565°C for a determination of the effect on the porosity of the metal in both welding seam and fusion zone and on the temperature dependence of internal friction (logarithmic decrement in damping) as well as of the moduli of shear and normal elasticity over the 20-650°C range. The results indicate an adequate stability of the mechanical characteristics of this steel after 120,000 h in service at 565°C and subsequent

thermal diffusion for 80,000 at 565°C. A shift of the high-temperature branch of the logarithmic decrement characterizing internal friction into the 545-565°C temperature range is to be expected after 250,000 h. References 5: all Russian.

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CHARACTERISTICS OF SURFACE LAYER FORMATION ON 45NiCrTi ALLOY DURING ELECTRIC-SPARK TREATMENT

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 6, Jun 86 pp 44-49

[Article by V. A. Strizhak, V. V. Kiselev, and A. A. Vaynshteyn, Ural Polytechnic Institute]

[Abstract] A study of electric-spark treatment of the dispersion-hardened 45NiCrTi alloy (Elinvar) was made, for the purpose of determining the structure and the composition as well as the properties of the surface layer formed in the process and its subsequent effect on the performance characterisitcs of tuning forks made of this alloy. Wires of L68 brass 0.15 mm in diameter were used as electrodes in five different machines with numerical program control. "Soft" treatment was done in machines with self-excited pulse generators: model 4531P with an RC oscillator and kerosene as medium, model DEM-15 with an Agiepuls-25LD oscillator and deionized water as medium, model LS-350A with a VH-02 oscillator and deionized water as medium, model A 207.46 with an RLC oscillator and industrial water as medium. "Hard" treatment was done in machines with separately excited pulse generators: model A 207.46 with an LE-717 oscillator and industrial water as medium, model 4531FZ with a GKI-250 oscillator and industrial water as medium. Treatment was followed by structural and phase analysis of the surface layer in a DRON-2.0 x-ray diffractometer with an FeK α-radiation source as well as chemical analysis in a MAR-2 x-ray microanalyzer. The surface layer appeared to consist of two sublayers, modification of the alloy matrix underneath a "slag." The analyses revealed three phase in the slag sublayer dependent on the interelectrode medium and on the mode of treatment: black C-phase - free carbon (soot) only after treatment in kerosene, yellow $\emptyset_1$-phase -solid solution of Cu,Zn (electrode elements) and Fe,Cr,Ni (alloy elements) with an f.c.c. crystal lattice (0.362 nm period) after "hard" treatment, $\emptyset_2$-phase - oxides similar to γ-Fe_2O_3 with an f.c.c. crystal lattice (0.835 nm period). The thickness of this sublayer was estimated from the change of crystal parameters. The mechanical characteristics of the alloy matrix in the surface layer were measured after "soft" and "hard" treatment, the macrostress or sum of principal stresses $-\sigma_1+\sigma_2$ being found to be tensile and to decrease with increasing depth below the boundary with the upper slag sublayer. A performance evaluation of tuning forks made of this alloy

reveals a significant difference between the effects of "hard" and "soft" treatment. The surface layer after "hard" treatment lowers the Q-factor to 200-500 and widens the variance of the temperature frequency coefficient to $\pm 10^{-5}\ K^{-1}$, even after optimum treatment. Gradual removal of this surface layer by electrical polishing restores the Q-factor up to 1600 and decreases the absolute value of the temperature frequency coefficient to that corresponding to a clean 45NiCrTi alloy. Removal of the surface layer after "soft" treatment does not significantly increase the Q-factor and narrow the $\pm 4 \cdot 10^{-6}$ range of the temperature frequency coefficient. These results have been confirmed by measurement and calculation of the temperature modulus-of-elasticity coefficient and the linear thermal expansion coefficient over the 20-80°C range, each indicating the degree of defectiveness of the surface layer, particularly of the slag sublayer, and the half-sum of both determining the temperature frequency coefficient. References 3: all Russian.

2415/12947
CSO: 1842/228

NEW SPECTRAL ANALYSIS PROBE DETERMINES MATERIAL COMPOSITION

Moscow MOSKOVSKAYA PRAVDA in Russian 26 Apr 86 p 3

[Article: "This Is No Longer Fantasy: Atom Voices Are Heard"; passage rendered in all capital letters printed in boldface in source]

[Text] TEST RESULTS HAVE BEEN RECEIVED FOR THE SPEKTROZOND [spectral probe], A SPECTRAL ANALYZING SYSTEM FOR DETERMINING THE COMPOSITION AND CHEMICAL STATE OF ATOMS IN ALLOYS, MINERALS AND OTHER MATERIALS.

The Spektrozond easily penetrates the depth of the material being studied. The tiniest piece of a sample is sufficient for analysis.

Candidate of Physical and Mathematical Sciences A. I. Kozlenkov, one of the Spektrozond developers and senior scientific staff member of the Metallurgy Institute of the USSR Academy of Sciences, tells us that "Electron optics, automation and computer technology equipment, and X-rays used in other modern analyzing instruments have enabled us to make analyses of insignificantly small quantities of a substance that can be measured to at least trillionths of a gram. But, unfortunately, these measurements give only the quantitative characteristics; they indicate which elements are contained in the sample. However, elucidation of the qualitative composition, that is to learn how much and in what volume light elements--from fluorine to lithium --are contained has so far been unsuccessful. We have developed instrumentation that is capable of making a complete analysis of a material to fill this need in modern instrument engineering.

And so, a method was found that forces the lighter elements of Mendeleyev's periodic system "to talk". We used the "light" X-rays emitted by the atoms of these elements as the means. The spectrum of such rays holds an intermediate position between the regular "hard" X-rays and ultraviolet. In nature, each chemical element responds to external action, for example to electron beam irradiation, and the radiation spectrum produced is unique to that element--the same way that each tuned string of a musical instrument is unique in its sound. Each element is excited by an electronic tip, one thousandth of a millimeter in size, so that each chemical element can be "heard". The responding radiation of the element is directed into

a spectrometer and, having identified it from the other rays, it is then sent into a detector. When the radiation passes this sensor it becomes visible on a display screen or is stored in the memory of an electronic computer. Thus, by touching the "strings" of the chemical elements with an electronic tip, the researchers get to know the element content in a studied sample.

The Spektrozond is a valuable instrument for analyzing metals, alloys, ores and minerals. Physical metallurgists can determine the new composition "anatomy" of a produced alloy with the aid of this instrument. Geologists will find traces of rare metals and valuable minerals even in the smallest rock samples.

A. K. Kulapov, chief engineer of the Institute's Special Design Bureau, has said,"Designers, manufacturing engineers, mechanics, installers and electronic specialists have had to exert considerable creative energy and inventive spirit to give a material form to the scientists' bold ideas. The work was conducted in close collaboration with specialists of the Metal Physics Institute of the Ural Scientific Center, USSR Academy of Sciences. As a result, optimal technical decisions without analogs were found in all the designs of the Spektrozond analytic complex. The Spektrozond will find wide application in science and production in the current 12th five-year plan."

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ELECTRON-SPECTROSCOPIC EXAMINATION OF COATING ON COPPER FOIL FOR IMPROVING TECHNOLOGY OF FOIL DIELECTRICS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 86 (manuscript received 4 Sep 85) pp 83-88

[Article by K. N. Reznichenko, T. S. Korotkova, V. N. Fedorov, S. A. Yefimenko, and A. V. Kocherova, Moscow]

[Abstract] A chromium coating on copper foil was examined by two methods using a "Kratos" ES-300 electron spectrometer in a vacuum of $2 \cdot 10^{-8}$ Pa. The method of photoelectron spectroscopy with a 1253.6 eV strong MgK_{α}-radiation source had a maximum resolution of 0.9 eV on the Ag line. The method of Auger-electron spectroscopy with a 5 keV strong electron gun had a maximum resolution of $0.2 \pm 0.04\%$. The bond energy was measured accurately within ± 0.2 eV. The coating was deposited electrochemically from a $K_2Cr_2O_7$ electrolyte at current densities of 0.5 A/dm^2 and 1 A/dm^2, on an adhesive copper layer predeposited directly from a $CuSO_4$ electrolyte. The specimens were etched with a beam of 2 keV argon ions at a rate of 5 nm/min. The distributions of chemical elements over the coating thickness were established in a "Physical Electronic" Phi-551 electron spectrometer at an etching rate of 10 nm/min, the charge being accounted for by means of the 285 eV CIS line as internal standard. The data were processed automatically by a "Nicolet" 1170 system with multiple signal storage. The results revealed a two-layer coating, its thick lower layer consisting of Cr_2O_3 and thin upper layer consisting of a mixture of oxides Cr_2O_3+ CuO or spinels, with metallic Cr and Cu as well as Fe,Mn,Ag,Ca,K,S,C,O_2 impurities including contaminants present. The oxides are more likely to form a spinel of the Cr_2O_3.CuO type in a coating produced with a higher current density and such a coating will therefore have a higher corrosion resistance than one produced with a lower current density. The electrolytically predeposited adhesive copper layer was found to be covered by a thin CuO oxide film without Cu_2O. References 7: 4 Russian, 3 Western (1 in Russian translation).

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EFFECT OF β-PHASE INSTABILITY IN ALUMINIDE COATING ON STATE OF SURFACE LAYER OF Ni-A1 ALLOYS AND ON ITS RESISTANCE TO SCALING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 86 pp 50-53

[Article by Ye. G. Lesnikova and V. P. Lesnikov, Ural Polytechnic Institute]

[Abstract] A study of the martensite transformation in the aluminide surface layer of heat-resistant Ni-A1 alloys was made, their heat resistance being determined by the aluminum content and by stability of the β-phase. Three such alloys were tested: 1) Ni+ 31.5% A1+ nickel monoaluminide; 2) Ni+ 23.5% A1+ substitutional solid solution with nickel monoaluminide as base; 3) Ni+ 21% A1 with β-phase solid solution above 1000°C reversibly transformable into martensite upon cooling to 75°C and lower. The heat resistance was determined from the increments of specific mass (kg/m^2) after slow low-temperature oxidation. Tests were performed at the temperatures corresponding to the operation of gas-turbine blades and necessary for obtaining a supersaturated solid solution in alloy 3, namely at 1050°C and 1100°C respectively. The curves of oxidation kinetics covering a period of 100 h reveal a transition from parabolic to linear scale buildup, after the oxide film has broken down and cleared the surface. The scale was found to be bonded most strongly to nickel monoaluminide. The stability of the oxide film was evaluated as the ratio of mass decrement after peel-off to mass increment after oxidation. The temperature dependence of the linear thermal expansion coefficient was measured over the 28-850°C temperature range, revealing a volume effect within the β(NiA1)⇄M(NiA1) transformation range. Dependence of the surface roughness on the number of 20⇄1050°C temperature cycles revealed a steep increase of surface roughness after the first few cycles and then a slower increase after subsequent cycles, with the surface of the unstable alloy 3 being all the time rougher than the surface of the stable alloy 2. The results indicate that the β(NiA1) → M(NiA1) transformation is detrimental, flaking of the oxide film lowers the heat resistance, martensite in the surface layer increases the surface roughness, and volume changes during forward and reverse transformations produce stresses causing breakdown of the protective film. Earlier studies have already revealed that there are two groups of favorable alloying elements. Those in the first group are strong stabilizers of the β-phase and not only shift its martensite transformation temperature below the operating temperatures (Si, Fr, Cr, 1% of each lowering the martensite transformation

temperature by 160°C, 75°C, 70°C respectively) but also widen the concentration range of β-phase existence. Those in the second group (Co) not only lower the temperature range of martensite transformation but also diminish the volume effect of $\beta(NiAl) \rightleftarrows M(NiAl)$ transformations. All these results can be extended to commercial ZhS6K and ZhS6U alloys. References 5: All Russian.

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UDC 669.295'1'781

COMPLEX IRON-BORIDE COATINGS ON TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 6, Jun 86 pp 18-19

[Article by A. S. Ivanov, Ye. S. Kuchina, A. N. Sokolov, and V. S. Tomsinskiy]

[Abstract] The low wear resistance of titanium alloys such as VT3-1 in friction makes it necessary to coat their surface. An iron coating is inadequate because of its softness; however, an iron-boride coating is most suitable because of its surface hardness and because it effectively isolates the titanium from the friction zone. The coating process involves electrolytic deposition of an iron strike first and subsequent boridation of the latter by diffusion in a hermetically sealed vessel containing boron or boron compounds in powder form. This technology produces a coating which consists of two layers, an iron layer underneath a layer of FeB and Fe_2B. For an experimental study of its characteristics, such a coating was produced on VT3-1 and on OT4 titanium first by boridizing the iron strike at 870°C with a mixture of boron carbide, potassium fluoroborate and aluminum oxide. The depth profile of microhardness revealed a maximum hardness of H 2300 throughout the upper boride layer, a sharp dip to a minimum hardness of H 150-200 throughout the lower iron layer, another sharp peak to a hardness of H 1800 throughout an intermediate layer containing intermetallic compounds TiFe, Ti_2Fe as well as β-phase and ω-phase titanium, then another dip to a hardness of H 450-500 throughout the base metal (alloy). Another set of coatings was produced by boridation of the iron strike with amorphous boron powder at various temperatures from 700°C to 930°C, whereupon the microhardness profiles were correlated with the phase composition as a function of the boridation temperature. Here phase analysis revealed formation of only Fe_2B at low temperatures, its amount increasing up to saturation at 800-850°C, then also formation of FeB beginning at 870°C in amounts which increase sharply at 930°C so as to reduce the formation of Fe_2B. Simultaneous formation of the two borides, each having a different thermal expansion coefficient, leads to embrittlement and cracking of the coating. On the basis of these results, the best coating is produced by boridation with amorphous boron powder below 900°C. References 1: Russian.

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SHORT-CYCLE ENDURANCE LIMIT OF BIMETAL STEEL PRODUCED BY SPUTTERING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 6, Jun 86 pp 52-53

[Article by V. Ye. Kozhevnikov, V. I. Arsenyev, S. I. Kirillov, and T. I. Sosnovskaya, Irkutsk Scientific Research and Design Institute for Chemical Machinery-Building, Uralkhimmash Production Association]

[Abstract] Four steels for high-pressure vessels subject to intermittent low-frequency dynamic loads (14CrMnSi, 09Mn2Si, 12CrMo, 22Cr3Mo) were clad with 12Cr18Ni18Ti steel by sputtering and then heat treated (manganese steels by quenching + tempering, molybdenum steels by normalizing, or normalizing + tempering, or quenching + tempering) before being tested for short-cycle fatigue in tension. The tests were performed in a GRM-2 machine at room temperature with soft asymmetric loading at a frequency of 220 cpm till rupture. The plasticity, characterized by percentage elongation and percentage reduction, was found to decrease after an increasing number of cycles till fracture. Local deformation with a wave profile appeared to develop within the bonding zone before cracking and eventual fracture. For reference all four steels, without cladding but after appropriate heat treatment, were also tested under the same conditions. No significant differences in strength and plasticity characteristics were noted, on a $3 \cdot 10^5$ cycles base. Such bimetal steels can, therefore, be used for high-pressure vessels.

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UDC 539.4.001:678.067

FRACTURE OF UNIDIRECTIONALLY ORIENTED BORON-ALUMINUM COMPOSITE MATERIALS UNDER COMPRESSION

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 86 (manuscript received 1 Apr 85) pp 226-230

[Article by A. N. Guz, M. A. Cherevko, G. G. Margolin (deceased), and I. M. Romashko, Mechanics Institute, UkSSR Academy of Sciences, Kiev]

[Abstract] The compressive strength of composite materials consisting of an aluminum matrix and boron fibers is evaluated, such materials being characterized by a very high and thus desirable strength-to-mass ratio. The boron fibers are assumed to be elastic, continuous, and parallel to one another. The aluminum matrix is assumed to be plastic, characterized by a power-law stress-strain relation $\sigma = A\varepsilon^k$, and to be incompressible. The boron fibers, all identical with a circular cross-section, are assumed to make ideal contact with the aluminum matrix so that under compression both components deform uniformly in the direction of fibers. When such a material is treated as a continuous medium, it becomes a transversely isotropic one for which the three-dimensional theory of stability yields the lower bound of ultimate strain ε_u as a function of the matrix volume fraction S with A,k and the fiber modulus of elasticity E as parameters. As a piecewise-homogeneous medium, such a material has a cellular structure with the axes of fibers assumed here to be passing through corners of squares in every cross-section. The corresponding system of two second-order differential equations for stress and displacement perturbation potentials is formulated in a cylindrical system of coordinates and has been solved in Bessel and Hankel series for the stability limit in shear with the fibers remaining parallel in the plane of buckling. Solution by the method of reduction and successive approximations has yielded the ultimate strain ε_u'. The ultimate stresses σ_u and σ_u' in the material as continuous medium and as piecewise-homogeneous medium, respectively, were calculated according to the relation $\sigma = ES\varepsilon + A\varepsilon^k(1 - S)$. For experimental verification, special specimens were prepared from VKA-1 unidirectionally oriented material (boron fibers 140 μm in diameter, AD-1 aluminum matrix) and tested in an "Emery Bolduni" hydraulic machine. First monolayers were produced by plasma sputtering of boron fibers on aluminum, whereupon these monolayers were stacked by diffusion welding at a temperature of 577°C under a pressure of 35 MPa for 10 min into 6 mm thick strips with ultimately a 50% fiber volume fraction. The strips were cut by electric-erosion treatment into 6 mm wide and 20 mm long bars.

One batch was then diffusion annealed at 477°C for 2 h with subsequent air cooling. Another batch was not annealed. All (32 annealed specimens and 14 unannealed specimens) were tested in compression at a loading rate of $3 \cdot 10^4$ N/min till fracture. The results yielded an average strength close within 1% to that of a "continuous" material and a maximum strength close within 15% to that of a "piecewise-homogenous" material. References 13: 11 Russian, 2 Western.

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DISCRETE STRENGTH SPECTRUM OF CAPRON FIBERS AND OF COMPOSITE MATERIALS WITH CAPRON FIBERS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 86 (manuscript received 8 Aug 84) pp 240-245

[Article by A. V. Danilov and A. G. Barteneva, Scientific Research Institute of the Rubber Industry, Zagorsk branch; Moscow Institute of Textiles imeni A. N. Kosygin]

[Abstract] A stress analysis of capron fibers has revealed a polymodal statistical distribution of rupture stresses. In this study the discrete strength spectrum is further analyzed for a determination of its role in the fracture of capron fibers, capron cloths, and rubber-cloth composites. Calculations are based on the theory of polymer fracture micromechanics with relevant formulas as well as on the results of low-angle x-radiography and structural examination by other methods. The data are presented in the form of differential curves describing the statistical distribution of rupture stress and rupture strain at room temperature for an individual capron fiber ($\bar{\sigma}_u$ = 467 MPa), for a capron cloth ($\bar{\sigma}_u$ = 787 MPa, $\bar{\varepsilon}_u$ = 27.0%), and for a rubber-cloth composite ($\bar{\sigma}_u$ = 704 MPa, $\bar{\varepsilon}_u$ = 24.5%). The results for a capron fiber indicate one low strength level corresponding to macrocracks, seven higher strength levels in the microcrack range, and five still higher strength levels in the submicrocrack range. For the capron cloth there are only the five strength levels in the submicrocrack range and one next lower strength level in the microcrack range. For the rubber-cloth composite there are only the two lowest strength levels in the submicrocrack range and the three highest levels in the microcrack range. This information should be useful for quality control of capron-fiber products. References 14: 11 Russian, 3 Western (2 in Russian translation).

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CONTACT STIFFNESS OF MULTILAYER CYLINDRICAL SHELLS, PART 2: MATRIX METHOD OF SOLVING CONTACT PROBLEMS FOR MULTILAYER CYLINDRICAL SHELLS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 86 (manuscript received 24 Jun 85) pp 276-280

[Article by B. L. Pelekh, A. V. Maksimuk, and N. N. Shcherbina, Applied Problems of Mechanics and Mathematics Institute, UkSSR Academy of Sciences, Lvov]

[Abstract] Problems of contact stiffness are considered for multilayer cylindrical shells as discrete media, with a separate hypothesis for each layer and with the number of layers largely determining the order of the system of resolvent equations. The matrix method is proposed for solving such problems and is demonstrated on a circular cylindrical n-layer shell symmetrically between two rigid and smooth pressing rollers. The problem is assumed to be two-dimensional with radial symmetry and axial uniformity. Each layer is described by a system of equations according to a Timoshenko theory which takes into account transverse shear strains, assuming an ideal coupling between layers (equal contact stresses and displacements at each interlayer boundary). The complete overall system of 2n+1 second-order differential equations with 4n+ 2 symmetry constraints for determination of the integration constants is reduced to a single first-order differential equation in matrix form, with s square elasticity matrix of order q dependent on the number of layers n. Solving this equation is equivalent to solving p+ 1 Cauchy problems, their solution in series leading to a linear Volterra integral equation of the second kind for the contact pressure under the rollers. The resolvent of its kernel is obtained with the aid of a Laplace transformation. The yet unknown contact region is then determined from the condition of equilibrium for a roller as a rigid body. With convergence of this method established on the strength of a theorem, numerical solution by this method has been programmed on a computer. The results for shells with an R/h= 32 ratio of shell radius to layer thickness made of a material with a Poisson ratio ν= 0.3 and an E/G'= 20 ratio of elasticity modulus to shear modulus were compared with results of an analytical solution by the method of integral Laplace transformation. Retention of 20 terms in the matrix series was found to ensure a satisfactory accuracy. References 12: all Russian.

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CONTACTIVE INTERACTION IN METAL-COMPOSITE HINGE JOINT

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 86 (manuscript received 12 Apr 85) pp 285-292

[Article by O. S. Sirotkin, G. P. Zaytsev, K. V. Kaykov, and V. B. Litvinov, Moscow Aviation Technological Institute imeni K. E. Tsiolkovskiy]

[Abstract] Interaction of a metal and a composite material in a hinge joint is analyzed, for the purpose of improving the performance of such joints and thus overcoming limitations on the use of composite materials for structural and machine components. As a model problem there is considered a metal moving in a hole in a plate of a composite material and nonaxisymmetrically distorting the hole contour. Assuming that the dowel is incompressible and its diameter is equal to the hole diameter, also that the edges of the plate are stress free, the distribution of contact pressure around the hole contour is determined from the solution to the S. G. Lekhnitskiy equation for the principal stresses σ_x, σ_y, σ_{xy} is an anisotropic plate. The state of stress and strain in the plate during motion of the dowel is then calculated by the numerical method of finite elements in the displacement formulation. This has been done for a 5.15 mm thick and 182x57 mm² large rectangular plate with a hole 14 mm in diameter and 52 mm away from the edge from which a dowel is inserted without clearance, through a slot. The orthotropic composite material of the plate, consisting of epoxy resin as binder and glass fibers as filler, has moduli of elasticity E_1= 4531.31 MPa and E_2= 3417.71 MPa, Poisson ratios ν_{12}= 0.385 and ν_{21}= 0.291, and a shear mudulus G= 1255.3 MPa. Axial symmetry allowed consideration of only one half of the plate, which was subdivided into a grid of 435 simplex anisotropic triangles. The results were compared with and found to agree closely with results of photoelastic birefringence measurements, namely with monochromatic interference patterns in violet light (wavelength λ = 435.8 nm), in green light (wavelength λ= 546.1 nm), and in red light (wavelength λ= 690.7 nm) obtained by passing the light from a mercury-arc lamp through appropriate filters and applying a force of 1000 N to the plate through the dowel. References 11: 7 Russian, 4 Western (1 in Russian translation).

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CORROSION PROTECTION METHODS FOR OFFSHORE METAL STRUCTURES

Baku BAKINSKIY RABOCHIY in Russian 3 Jun 86 p 2

[Article by Z. Kuperman:"Attention: The Problem--To Protect Offshore Foundations Against Corrosion"; passages rendered in all capital letters are printed in boldface in source]

[Text] A SIGNIFICANT NUMBER OF OFFSHORE STATIONARY PLATFORMS ARE SCATTERED OVER THE CASPIAN SEA. THERE WILL BE EVEN MORE PLATFORMS WITH CAPACITY GROWTH OF THE PLANTS PRODUCING UNDERWATER FOUNDATIONS. STABLE ADVANCES HAVE TO BE ACHIEVED IN DEVELOPING THE SHELF, AND HERE MUCH DEPENDS ON HOW SUCCESSFULLY THE RELIABILITY AND LONG SERVICE LIFE OF THE METAL STRUCTURES CAN BE ENSURED. THEIR CHIEF ENEMY IS CORROSION. HOW IS THE METAL BEING PROTECTED AGAINST CORROSION?

NIPI [Scientific Research and Design Institute] Gipromorneftegaz [State Scientific Research and Design Institute of Offshore Oil and Gas] is the chief designer of offshore stationary platforms in the Caspian Sea. A. Khanlarova, chief specialist on corrosion and doctor of technical sciences, involved us in a number of serious and urgent problems with her very first words.

"The structures operate under cyclic loading." she told us, "that is, under conditions when even high-strength steel is exposed to failure due to corrosion fatigue, cracking, and other similar causes. Frequent inspections, particularly of welds and bonds connecting the supports, are essential to ensure safety performance. And to do this is impossible so far."

Now a clearer definition apparently is needed of what is amenable to decision and what for one reason or other is a cause for alarm. A stationary platform operates in four zones at the same time. The first part of the structure is in the earth at the bottom of the sea, the second part is in seawater saturated with salts and dissolved oxygen, the third part is in the zone of periodic wetting (at the air-water boundary) and, finally, the fourth part is at a height which cannot be reached by water. Accordingly, the conditions and methods of protection against the destructive action of corrosion are different.

Recommendations, dealing with which method a structure may be protected in a given part, can be found at NIPI Gipromorneftegaz. For example, specialists at the institute have put many of their findings into the protection system of the periodically wetted structure part. Now this structure part is maintained without repairs for a long period of time in the offshore foundations, particularly those that are produced at the enterprises of the VPO [All-Union Production Association] Kaspmorneftegazprom [Caspian Offshore Oil and Gas Industry]; we do not have to worry about this part anymore. However, the underwater part of the structure still remains "helpless".

I had a chance to see a monoblock, a first for Kaspmorneftegazprom and ready for offshore installation, that will hold an entire platform by itself. This is what amazed me, I can't think of any other word: only the top, above-water part was painted.

How is the problem of protecting the part that is in the water solved? So far, not in any way.

Protection against corrosion is sort of provided in the offshore platform designs. However, there are no real practical actions, nor even a well lined-up solution or single opinion as to how this is to be achieved.

V. Araypetov, chief of the Production Department for Operation and Repair of Offshore Structures of the Kaspmorneftegazprom Association, justifies the situation. He said, "We generally receive the designs already after the offshore foundation has been installed into the bottom of the sea."

Design delays, when the manufacturers and builders have "to go ahead of the locomotive", are regrettably becoming chronic. Why? The customer does not demand blueprints of the protection systems: his main concern is to produce gas and oil faster. In turn, the designers do not hurry very much with giving out the designs because they are not sure of the efficiency of the proposed schemes nor are they sure that realization of designs will be started energetically, in a real way.

Two types of corrosion protection are known: protector and cathode. The first is widely used for the underwater part of vessels and for offshore foundations which are not installed very deeply. The principle of this type is that aluminum ingots--protectors--weighing 65 kilograms are attached to the structure surface at specific intervals. An electric current forms between the protectors and metal structure that results in repelling the oxygen dissolved in the water, and oxygen is the main destructive force in corrosion. The protectors gradually dissolve, thereby saving the metal of the structure; so, it is not by accident that they are known as "sacrificial" anodes. However, this type of protection is not always convenient. The hanging of the required number of protectors on large

offshore platforms means an additional load on the blocks--from 300 to 700 kilograms. This impairs the conditions for haulage and installation of the blocks offshore and, in addition, increases the wave induced rolling loads on the platform. For this reason, the institute designers are decidedly against this method for deep water foundations, and they support their objections with specific estimates.

Are there other methods? Without going into details, I will reply that they are combined under the term--cathode protection. Here again, the main role is played by electric current, but in principle the voltage potential is produced in a different way. The main point is that there is no need for heavy protectors. The principle of other methods is that anodes of a given metal are lowered into the water next to the platform and voltage is supplied to them.

Three years ago, the collective of the Electrochemical Protection Laboratory, headed by Candidate of Technical Sciences M. Abdullayev, proposed the use of a ferrosilicon anode, that is, an anode made of a cast iron variety. It was assumed that this anode will be tested on operating platforms. The anode was really quite huge and weighed three tons, but it was not so huge that the Kaspmorneftegazprom Association could not "lift" it. Alas, it turned out exactly this way. Long painful ordeals started because a manufacturer could not be found to make it. However, as early as 1984 the first anode was finally made. At the same time, the association commission under the chairmanship of V. Ayrapetov drew up a document with an encouraging conclusion: the experimental sample was recommended for industrial production. It was decided that it be installed on one of the platforms to test its fitness for service before this type of protection was widely developed for other foundations. Unfortunately, that is where everything ended. To this day, the anode is still lying on the shore. Here also is its circuit of wires.

A. Troshkina, senior engineer of the association's Department for Offshore Structure Operation, and I drove to all the departments that were to be engaged in installing the offshore anodes. Before an anode is sent to its place of service, it should be equipped with a concrete pedestal and together they are lowered to the bottom of the sea. The SSMU-4 [Specialized Construction and Installation Administration] of the Kaspmorneftegazstroy Trust did not carry out this operation. Installation was entrusted to SMU-1 [Construction and Installation Administration] of the same trust, but they did not even start although the association instructed them to do so many times. The Trust Collective Manager O. Rzayev explained the delay by the fact that he had not been able to secure the use of "Azerbaijan" crane ship for this operation. The ship was known to be loaded to its limit. However, later it was learned that a regular tugboat or a lower capacity crane ship could do the job as well. In short, there was much talk as well as looking for "objective" reasons to justify the red tape, instead of doing the job.

Now, another protection variant--the use of platinum plated titanium tubes as an anode. Of course, their cost is higher than that of regular equipment, but they have their own advantages. The tubes may be installed directly inside a support structure as they take up less room and they may be readily used together with protector protection, installed in the bottom part of deep water foundations. This is planned for the new platforms. The association was allocated a specific amount of platinum which will be sufficient for protecting several platforms. However, the job now is to determine where the production of such anodes should be set up. The potentialities, known to the institute and association, indicate that anode production cannot be running smoothly earlier than in two-three years. But, by that time several deep water stationary platforms will already be put into operation by VPO Kaspmorneftegazprom alone.

Finally, there is still one more protective method, particularly for the most dangerous points of a structure--the welds. This method is known as metal bonding, a treatment in which a special mixture is deposited. This method is known and is partially used, but not in the volumes needed because the technology is insufficiently developed. Here, a search is required that is urgent and in the spirit of today's requirements.

It should be added to the above that almost all the mentioned methods of protection against corrosion produce a good effect only when they are combined with a well painted surface.

"In this case," said A. Khanlarova, "the electric energy requirements are reduced by more than a factor of one hundred with cathode protection."

This meansthere is a potentiality for preventing not only corrosion, which reduces the mass of underwater metal structures, but also those types of corrosion which destroy the structure itself and, thus, are particularly dangerous, even for the strongest steel. Offshore stationary platforms are long-term structures and, for this reason, their protection against corrosion should be approached in a business-like manner: one should not only think about how much hydrocarbon raw material can be extracted with the use of platforms, but about their maximum reliability and life service as well.

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EFFECT OF LASER ACTION ON STRUCTURAL STATE AND CORROSION RESISTANCE OF ZIRCONIUM ALLOYS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 86 (manuscript received 21 Feb 85) pp 30-33

[Article by I. A. Tregubov, L. N. Yevseyeva, S. B. Maslenkov, A. A. Uglov, M. G. Ignatyev, S. A. Semakhin, and I. Yu. Smurov, Moscow]

[Abstract] An experimental study of laser action on the surface of a zirconium alloy containing 1% Nb was made, for the purpose of supplementing available data on hardness, strength, and corrosion resistance in hot water. Specimens of this alloy in the form of 1.5 mm thick square 10x10 mm² plates were treated with radiation from a GOS-1001 neodymium laser in the free-emission mode and in the Q-switching mode, its characteristic power density being varied over a range of $P_{max}/P_{min} = 10^4$ so as to cover sweating and no sweating of the alloy surface. The treatment was done by pulses of 0.8 J energy without sweating in an argon atmosphere, by pulses of 3.5 J energy without sweating in an argon atmosphere, by pulses of 1.5 J energy without sweating in a nitrogen atmosphere, by pulses of 3.5 J energy with sweating in a nitrogen atmosphere, and by pulses of 4.5 J energy with sweating in a nitrogen atmosphere. Microstructural examination before and after treatment revealed changes, including formation of an inner layer as large as the laser spot recrystallized after melting and an outer layer full of microcraters. Laser action with sweating had increased the microhardness appreciably throughout, while after laser action without sweating the microhardness was lower within the action zone and the same underneath. The alloy surface was also found to have been etched by gas and ion streams emanating from the action zone. Corrosion resistance was measured in water at 350°C temperature under 170 atm pressure. It was found to have changed after laser treatment, increasing after treatment in an argon atmosphere and decreasing after treatment in a nitrogen atmosphere. There was little or no effect on the corrosion mechanism and the law of corrosion kinetics. References 3: 2 Russian, 1 Western.

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EFFECT OF COLD PREDEFORMATION OF 12Cr18Ni9Ti STEEL ON ITS CAVITATION-CORROSION RESISTANCE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 6, Jun 86 pp 57-59

[Article by V. V. Berezovskaya, Yu. G. Veksler, and N. A. Manakova, Ural Polytechnic Institute]

[Abstract] A cavitation-corrosion study of 12Cr18Ni9Ti stainless steel after deformation at -196°C (liquid nitrogen) was made, for the purpose of determining the effect of such a treatment and its mechanism. The degree of $\gamma \rightarrow \alpha$ transformation was determined by the degree of deformation, the latter varying over the 10-52% range. Specimens were loaded in a 30 t tensile testing machine and then selectively cut for further study. The martensite content was determined on the basis of x-ray examination in a URS-50IM chamber with an FeK_α -radiation source. Corrosion was measured in a 0.5 M H_2SO_4 solution at a temperature of 20°C, a UZDN-1 ultrasonic oscillator on the specimen simulating cavitation at a frequency of 22 kHz with an amplitude of 20 μm. It was measured by the loss of mass, on the polarization curves plotted with a P-5827M potentiostat, and according to Faraday's law of electrolysis, in 3 h tests. Corrosion during cavitation was also measured in 18 h tests on specimens with 5% and 90% deformation martensite as well as on specimens not precooled and thus having a purely austenitic structure, with the corrosive medium separating the specimen from the ultrasonic radiator. The steel with 90% deformation martensite was found to have the highest cavitation-corrosion resistance, evidently owing to its better hardenability. Accordingly, cold plastic deformation which lowers the phase stability of 12Cr18Ni9Ti steel and results in formation of martensite also increases its cavitation-corrosion resistance. This resistance does not depend on the percentage deformation up to 30% but changes in correlation with the percentage deformation above 30%. References 7: 5 Russian, 2 Western (1 in Russian translation).

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GIGANTIC BLAST FURNACE NEARS COMPLETION

Moscow PRAVDA in Russian 21 Feb 86 p 2

[Report by PRAVDA correspondent Yu. Zhigaylov: "Gigantic Blast Furnace before the Start"]

[Text] Cherepovets, Vologda Oblast, 20 February. The final stage of construction of a gigantic blast furnace has begun. Yesterday at the construction site they counted time no longer in days, but literally in hours. The Severyanka Blast Furnace has been set up for drying.

This is the final stage of its construction and, simultaneously, its first production operation. The metallurgists have now taken over completely at the blast furnace. The first phase alone will yield 3.5 million tons of pig iron in a year. The 14,000-man collective of builders endeavored to hasten the first smelting. The refractory specialists of "Soyuzteplostroy" (expansion uncertain: probably "State All-Union Construction and Installation Trust for Heat Engineering; possibly subordinate to the Main Administration for Installation of Heat Engineering and Insulation Work, USSR Ministry of Installation and Special Construction Work) worked especially harmoniously during the pre-start-up period, completing the heat-resistant "jacket" for the blast furnace ahead of schedule. The brigade of Yu. Paranichev gained more than 1 month by changing the equipment assembly sequence. Almost daily important objects, of which the "Severyanka" has over 200, became operational early. They also worked out a way to reduce the final stage of construction by changing the traditional process of oven drying. This means that the most important point of the pre-congress commitments will be fulfilled ahead of schedule.

About 2,500 metallurgists who will service the furnace are making final preparations for the first smelting.

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ANTICORROSION MEASURES AT BELORUSSIAN OIL REFINERIES

Minsk SOVETSKAYA BELORUSSIYA in Russian 22 Feb 86 p 2

[Article by V. Fakeyev under the "Operation 'Metal'" rubric: "Millions from Rust"]

[Text] While being surprised at the forces of nature, we would hardly categorize corrosion of metals on a par with earthquakes and typhoons. However, the losses from it are greater than all natural disasters combined. Experts have calculated that cost of corrosion to our country each year is estimated to be a sum exceeding the total budget of several union republics--13-14 billion rubles.

It also costs the Novopolotsknefteorgsintez Production Association a tidy sum. It spends 600,000-700,000 rubles annually for anticorrosive measures.

This began our conversation with V. Volodkevich, senior engineer for corrosion of the technical inspection department.

"Vyacheslav Ivanovich, let us imagine an enormous set of scales," I proposed. On one scale we will have all the metal resources of the enterprise--pipelines, equipment, tanks, fittings--in short, everything that is subject to corrosion. On the other scale we will put a counterweight. How much must it weigh?"

"Approximately 100,000 tons."

"How much of this metal is written off each year as scrap?"

"Between 600 and 700 tons. But these are only the direct losses. The appetite of "old dame rust," as popularizers of science sometimes call corrosion, is not limited to this. There are also indirect losses which at least double the direct losses. Therefore, our anticorrosive measures are aggressive in nature. We arm ourselves with everything modern science can offer in the area of metal protection."

Vyacheslav Ivanovich talked about the chemical engineering method used at crude oil refineries to fight corrosion.

AN ANTICORROSIVE "COCKTAIL"

In addition to demineralization and dewatering of petroleum, that is removing the allies of corrosion from it, crude oil refineries simultaneously use the reverse method of protection. Alkali, a solution of ammonia water, inhibitors, and substances decreasing the corrosiveness of the atmosphere are introduced into the process system.

In the past, such an additional feeding was accomplished at each plant individually and by the level of mechanization and equipment with monitoring and recording instruments was quite primitive. The operations were performed manually, the solutions injected one at a time, their doses determined by eye, and the tanks with the agents poisoned the air with fumes. In short, its organization was primitive, wasteful, and unsafe.

Several years ago, the Novopolotsk refinery workers decided to centralize the feeding of neutralizing solutions and to inject them into the system not one at a time, but mixing them in advance and making a sort of "cocktail" of them.

Associates of the Special Design Bureau of the Neftekhimavtomatika Moscow Scientific Production Association helped the production engineers automate the system. It is efficient. It is now in the experimental and operational testing stage. The expected savings are 400,000 rubles per year.

AND HERE WAS THIS BIG FIELD....

"If you were attentive in passing by the refinery's water units," V. Volodkevich continued, "you couldn't help but remember the huge funnels crowning these structures. These are diffusers."

He recalled the events of 30 years ago.

Before 1972, corrosion had a great tendency to select these very diffusers for its devastating forays. The area of each is 250 square meters. The association has 92 of them. Consequently, the area of this equipment is 23,000 square meters, roughly 3 football fields. That was where rust would spread.

What was the cost to the oil refinery workers? Some 20,000-25,000 alone rubles in labor costs for major repair of the diffusers each year. Add to this the 25-30 tons of sheet metal the repairmen used to patch the holes each year, and the 3 tons of scarce anticorrosive paints, and it will become clear why the workers of the association gave corrosion a decisive battle on namely this "field."

They decided literally to tear the ground from under rust--to use fiberglass diffusers in place of metal ones. The results were better than all

expectations. The fastening bolts rust, fall off, and melt away before your eyes, but the fiberglass is like new.

Now the association has 70 "invincible" diffusers on the water units. There are 20 more ready for installation. Soon in this production section, metal will give way completely to advanced materials which corrosion "cannot get its teeth into."

UNUSUAL HAULING

Vyacheslav Ivanovich made one more excursion into the history of the enterprise.

Several years ago one could observe the following picture at the plants of the petroleum giant. An malfunctioning heat exchanger was being repaired. It was necessary to pull out the "filling" from it--a pipe bundle. But the apparatus weighed 10 tons. Moreover, it was thoroughly "clogged with coke," that is, on the inside it was covered with deposits of petroleum derivatives every bit as hard as asphalt. In short, with great difficulties they pulled out the bundle using a highly powerful pipe-laying machine specially adapted for such unusual hauling.

Now the repairmen have at their disposal special pushers developed by the plant's skilled craftsmen and modern hydraulic giants. Nevertheless, repairing the heat exchanger remains a labor-intensive job. It is difficult to clean the metal "honeycomb" of 4,000 pipes up to 6 meters long. Where the water stream is weak is where the dip-rod made of reinforced metal goes. That is where the dip-rod begins to get encrusted--and it starts to chip. All this is due to the inevitable deposits which stimulate the start of corrosion.

The workers of the association have called upon ultrasound to combat the deposits of petroleum products. The GIU-T ultrasonic pulse generators were initially tested on the leading primary petroleum refinery plant, and later on two primary plants and on a plant for dewaxing of oils.

Well, what of it? Whereas before the heat exchanger had to be opened two and sometimes three times a year, now they get by with one repair. Naturally, this serves the purpose for personnel servicing the plants: the time between maintenance of equipment has increased. That means it is easier to carry out the production schedule. The repairmen are also satisfied because this victory over rust has made their work easier.

By the end of 1986, 16 more of these generators will be installed in addition to the 8 already in operation. It is not difficult to calculate the savings from the new attack on corrosion: major overhaul of one heat exchanger costs the association 1,500-2,000 rubles.

A FEW WORDS IN SUMMARY

To date there are about 100 fiberglass diffusers in operation in all of the domestic petroleum refining. As I recall, 70 of them are "assigned" to Novopolotsk. The chemical engineering method of protecting primary petroleum

refineries in its automated variant is also pioneering work not having an analogy in related enterprises of the sector. The Novopolotsk workers are leaving their colleagues behind and are also the forerunners in certain other directions in the fight against corrosion.

Hence, there is naturally interest in the Belorussian experience. People come here from Angarsk, Omsk, Groznyy, Perm, Odessa, and other petroleum refining centers. The innovators from Novopolotsk are willing to assist them because the steep advance which faces the national economy in the coming years is difficult to make alone and because the achievements of one enterprise must enrich all. This is a requirement of scientific and technical progress. This is a law of our socialist morals.

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INCREASED EFFICIENCY AT NOVOLIPETSK METALLURGICAL COMBINE

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 12 Mar 86 p 2

[Article by I. Frantsenyuk, director of the Novolipetsk Metallurgical Combine imeni Yu. V. Andropov, Hero of Socialist Labor, delegate to the 27th CPSU Congress: "Search Strategy"]

[Text] WORK EFFICIENTLY!

One day at a worker meeting, the conversation turned to the fact that there was a constant shortage of slabs for the "2000" mill, which was picking up force. Something had to be done because there was little hope for imported stock. The converter operators of the first shop responded with the call: "Rated capacities are not the limit!" There was a proposal to redesign the existing production facilities. Now we produce 4 million tons of steel per year in the same area instead of 2 million. Furthermore, each ton of increased capacity was one-third the cost of new construction. It would not do any harm to think about this at the sector headquarters.

Following the example of the first converter shop, the steel smelters of the second shop decided to modernize their equipment. Despite the fact that this shop was built later and had more modern equipment installed, using the experience of their colleagues, the converter operators boldly undertook the modernization. They managed to exceed the rated capacity by one-fifth in the same production area, and did so with less expenditures than their neighbors.

One can judge just how beneficial the technical re-equipment and production modernization have been according to production cost. Our cost per ruble of output in producing metal is now 75.94 kopecks.

By rights, the collective of the third sheet rolling shop is considered the leader in the competition for economy. Here the fuel expenditure per ton of rolled stock is the lowest among related shops of the sector. How did they manage to achieve this? Even after a number of innovations saving materials, raw materials, and electrical energy, the workers and specialists understood there were still some reserves.

"In our shop, 95 percent of the workers are covered by the brigade form of labor organization and incentives. We all know what a favorable effect this

has had on increasing labor productivity. Why couldn't we use the collective form of labor in the cause of economy and thrift? Let us set up a system for keeping track of fuel for each shift by brigades," brigade leader A. Saushkin proposed at one of the meetings.

So it was decided. A special paragraph was written into the commitment and a log book was acquired. Like a mirror, it reflected the successes and shortcomings. Those lagging behind had to catch up with the rest. Now there is not a single brigade in the shop that does not have savings over and above the plan. Today 94 kilograms of fuel are expended per ton of rolled stock, whereas it was 117 kilograms per ton 5 years ago.

The initiative of our metallurgists for introducing waste-free production processes is worthy of attention. Cooperation with the Ural Scientific Research Institute of Ferrous Metallurgy, the State Institute for Planning Metallurgical Plants, and other institutes helped. In the blast furnace process we are working practically without waste. The steel smelters and rolling mill operators are close to this. Documentation has been prepared for building plants for processing iron-containing slurry, 3 million tons of which has accumulated.

An operational complex for processing waste makes it possible to obtain additional agricultural fertilizer, crushed stone, pumice, and granulated slag. About 40,000 tons of metal are extracted at the same time. Just using slag as a recycling product yields a savings of more than 4 million rubles per year. Another important reserve is the use of secondary heat resources. By using them more than half the combine's need for steam is covered and more than 5 million rubles are saved.

Today at the combine a large shop is being constructed for producing cold-rolled dynamo steel, which will be equipped with automatic control systems. Its first section should already be in operation in the first half of this year, and the second should be operational in 1987. The builders, fitters, and operators completed assembly of the first section by the opening of the 27th CPSU Congress and have begun start-up and adjustment work.

Introduction of the shop promises the national economy tremendous benefits: the level of electrical machine building will increase and production of competitive electrical motors and equipment will be set up. Their weight will be nearly one-third less compared to those currently produced. Moreover, it will be possible to abandon completely the purchasing of sheet steel abroad, and electrical machine builders will be able to save up to 100,000 tons of metal and many other materials each year. The new specifications of the electrical equipment in general throughout the country will make it possible to save about 3 billion kilowatt-hours of electrical energy.

Quite a bit has been done, but there are still enough complications. More than once they have forced the leaders of industry to act contrary to economic logic. Today we are searching for ways of more precise and rhythmic work.

METAL TO ORDER

In our search we are relying on the initiative and creativity of people. We cannot obtain only high-quality products any other way. The leading brigade of senior steel worker A. Chegrakhchi, for example, pledged to smelt 10,000 tons of metal more than the quota. Others have followed. Among the rolling mill operators this includes the brigade of A. Govorov, which has promised to roll 12,000 tons of metal in addition to the plan and only excellent quality as well.

The patriotic movement has been strengthened organizationally, technically, in a word, comprehensively. All subdivisions are searching for new approaches. The specialists of the combine's central laboratory have established close contacts with a number of sectorial institutes and laboratories of the Central Scientific Research Institute of Ferrous Metallurgy, exchange information, and help the control service and engineers to monitor the novelties more closely and know the demands placed on certain types of metal products.

Characteristic in this light is the example of our cooperation with the Volga Motor Vehicle Plant. For its normal operation we were faced with incorporating production of cold-rolled motor vehicle sheet steel, and it had to be just as good as the best in the world. A council was set up which included the leading specialists of our two enterprises and the Central Scientific Research Institute of Ferrous Metallurgy. Purposeful, creative work yielded good results: The motor vehicle builders are quite satisfied with the quality of the sheet steel. In general, almost one-third of our output now conforms to the highest quality category, which is an eightfold increase compared to 1980.

Socialist competition for the honor of a plant brand has helped us solve many major problems. This includes setting up industrial steel production for oil and gas pipeline large-diameter pipe, creation and assimilation of the world's first major converter smelting complex and working of molten steel outside of furnaces, and so forth. Each year the combine receives a supplementary payment amounting to millions of rubles for high product quality.

The combine uses a targeted, comprehensive approach to fulfilling orders and ensuring production rhythm. A system using computers for monitoring fulfillment of deliveries is being introduced. The "Avtolist" subsystem included in it will monitor everything, beginning with metal smelting and ending with the shipment of the finished product. This would seem to be good. But what will we monitor if the production facility itself starts to limp?

Here an element of complexity is being worked out which would preclude any surprises. With the short duration of converter smelting of steel, the delivery of pig iron strictly according to schedule is no simple task. However, there are considerable reserves hidden here. Putting them in service means to gain. Thus, competition emerged under the motto "From steel according to schedule--to rolled stock according to orders." Inheriting the experience of the Ural steel makers M. Ulin and P. Satanin and Zhdanov steel smelter G. Gorban, our masters went further and made bridges not only between

the plant suppliers, but also between us and the clients. This has yielded a great deal.

For a more rhythmic supply of pig iron, the blast furnace operators incorporated precise calculations into the schedule. They reduced the idle time of equipment by speeding up repairs, replacing tuyeres, and other work. The steel makers incorporated assemblies for working metal outside of furnaces, used a complex of machines for repairing linings in converters and ladles, and other innovations. The rolling mill operators achieved a 0.1 percent reduction in planned idle time. As a result, an additional several thousand tons of sheet metal was rolled.

It would seem that much has been done to ensure 100 percent fulfillment of orders. Unfortunately, it has not yet been possible to achieve this. Contract commitments for last year were 99.6 percent fulfilled. They only missed by a trifle, but the fact remains. They have begun to analyze the reasons.

At one time, the specialists of the combine developed an automated system of production loading. In the first phase it performed well. But production increased, and the system lagged behind the demands of the day. Operational information about the shipment of metal by job authorizations and about surplus finished and semifinished products was gathered manually and, therefore, was processed very late. The appropriate services could not effectively influence the course of deliveries. Improving this section, we began working with computers. We calculate the technical production quota and sale of finished products at three levels: the director of the combine, the chief of the shop, and the brigade leader. Things took a turn for the better.

Since January of last year, the combine has been working under conditions of an economic experiment. This is what has helped us to discover and eliminate certain obstacles cropping up in the "manufacturer-consumer" chain. The reorganization has not yet been completed, and obviously it is not advisable to put off "until later" the resolution of certain urgent problems. It would be good, for example, if the union Gosplan and Ministry of Ferrous Metallurgy would establish procedures for approving the plan for the next year no later than August of the current year. It appears that it is also time to abandon the practice of issuing additional job authorizations for delivery for an existing or proposed plan overfulfillment.

TO A COMBINED SCHEDULE

The 27th CPSU Congress set major new tasks before the metallurgists for the 12th Five-Year Plan. It calls for substantial growth for long-range until the year 2000. How best to ensure this growth as applicable to our conditions? The recent party and management aktiv answered this question. Critically assessing the results achieved, the metallurgists seriously analyzed the work in party organizational, economic, and social spheres. Furthermore, it was emphasized that this involved moving to a qualitatively new level of management, fundamentally new production systems, and new-generation equipment. The critical remarks and proposals made are now being summarized so that the comprehensive program of speeding up scientific and technical

progress worked out in detail can be implemented more successfully. This is within our power.

But problems remain which are beyond our competence. In the 12th Five-Year Plan the combine is to build the "2500" mill with a capacity of 8 million tons of rolled stock per year. But there is still no general equipment supplier which could comprehensively resolve the problems of planning and deliveries. We cannot allow the equipment to be delivered in an incomplete manner without preliminary controlled assembly of the components, as has often been done before. Months are spent on its adjustment, alteration, and sometimes complete replacement.

There are, of course, examples of a different sort. We have a powerful complex for producing cold-rolled sheet steel built and operating successfully, one of the best in the world. The entire delivery and acceptance report after putting it into operation fit on one page, on which the main point stated was: "Neither the supplier or the buyer have any claims." I believe that this is the only way to establish relations between partners.

Our collective was the initiator of the all-union socialist competition for successful fulfillment of plans and quotas for 1986 and speeding up technical re-equipment of the sector. There is every reason to hope that this time as well the Novolipetsk metallurgists will remain true to their best traditions and honorably keep their word.

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NEW GRADE OF STEEL FOR OPERATION AT LOW TEMPERATURES

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 30 Mar 86 p 2

[Report by SOTSIALISTICHESKAYA INDUSTRIYA correspondent I. Mordvintsev in Volgograd: " 'Severyanka' is Working"]

[Text] Shops of the Volgogradneftemash (Volgograd Petroleum Machine Building) Association have begun manufacturing gas field equipment from a new grade of steel unofficially named "Severyanka." Equipment manufactured from it operates reliably even at temperatures of -70 degrees.

The new grade of steel and the technology for manufacturing gas field equipment from it were a joint development by specialists of the All-Union Scientific Research and Planning Institute for the Technology of Chemical and Petroleum Equipment-Making, the Electric Welding Institute imeni Ye. O. Paton, and also the Volgogradneftemash Production Association and the Tallinn Machine Building Plant imeni I. Lauristin.

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INTRODUCTION OF NEW TECHNOLOGY IN METAL PRODUCTION ADVOCATED

Moscow IZVESTIYA in Russian 6 May 86 p 1

[Article: "There Must Be A Proprietary Attitude Toward Metal"]

[Text] The country's metallurgists have a stepped-up assignment in the first year of the 12th Five-Year Plan: To bring the volume of rolled ferrous metal products up to 111.1 million tons and of steel pipes, up to 19.8 million tons without increasing the output of cast iron and iron ore. They count on a structural and technical reorganization. Thus, they will have to lower steel smelting by obsolete methods, that is, in open-hearth furnaces, and to increase its production in converters and electric furnaces and by means of direct ore reduction. Such modern production facilities will be put into operation at the Oskolskiy Electrometallurgical Combine in Belgorod Oblast and the Moldavian Metallurgical Plant in Rybnitsa. A rapid renovation and development of the by-product coke industry are planned at Nizhniy Tagil, Chelyabinsk, and Magnitogorsk metallurgical combines and at Krivoy Rog, Donetsk, and other by-product coke plants.

Metallurgists have begun the new five-year plan confidently. During the first quarter the plan for the output of all basic types of products was fulfilled and a significant increase in production volumes, as compared with the same period of last year, was attained. In the competition for a successful fulfillment of the assignments of the first year of the 12th Five-Year Plan the collectives of Novolipetsk, Elektrostal, and Dneprospetsstal plants, which supply metal for the most important purposes for machine building, instrument making, and motor vehicle, chemical, and other sectors, show examples of highly productive labor. Things are going well for metallurgists at Asha and Omutninsk plants. Several thousands of brigades of steel workers in the sector compete for the custom manufacture of rolled metal products with the State Badge of Quality for consumers.

Of course, the sector's confident start deserves praise, but there are no grounds for complacency. The demand for high-quality metal in the national economy is very high and by no means have all the potentials been activated in the struggle for high efficiency of production and quality of metal. A precise observance of technological discipline, output in strict correspondence with standards and specifications, and delivery of metal according to the prescribed assortment and in conformity with contracts and orders are the main potentials.

The path to a high quality of metal is most directly connected with the introduction of new technologies. As practice shows, there is something to work on here. For example, let us take the introduction of continuous steel pouring units, which have proved their value in Nizhniy Tagil, Lipetsk, and other metallurgical centers. The manufacture of rolled metal products according to the old scheme of "ingot-blooming mill-sheet mill" usually leads to metal losses of 30 to 40 percent. However, the use of continuous steel pouring units raises the coefficient of finished output and makes it possible to obtain an additional 7.5 to 8 million tons of high-grade steel annually on a countrywide scale. When this scheme is introduced, it is possible to expand the assortment of finished metal significantly.

Meanwhile, continuous billet casting machines are introduced into production in an extremely slow way. Pouring by the continuous method at the enterprises of the Ministry of Ferrous Metallurgy in relation to the total steel smelting volume is lower than in some foreign countries which have bought licenses from us. The scale of utilization of advanced methods of production of steel, smelted steel in particular, in electric slag, vacuum-arc, vacuum-induction, electron-beam, and plasma furnaces is small. In order to more rapidly obtain a yield from innovations, it is necessary to maximally strengthen relations between metallurgical enterprises and scientific institutions searching for advanced solutions and to increase the responsibility for shortening the periods of their introduction.

The potentials for saving metal in the sphere of its consumption are considerable. It is no secret that the metal intensiveness of domestic machines often is much higher than that of foreign analogs. This applies to single-bucket excavators, scrapers, forging-pressing equipment, motor vehicles, and equipment for light and food industries. The rates of replacement of rolled steel products with more economical polymer materials are slow, and serious design miscalculations are manifested. Today from each ton we produce much less output than possible. This means that it is necessary to energetically improve the structure of production of metal products and to more rapidly develop billet production in machine building.

Or, for example, capital construction. During the planning of many projects advanced consumption norms force their way through with difficulty and unsubstantiated safety margins are not rare at all. The head institutes of the USSR State Committee for Construction Affairs, creating plans for industrial buildings and structures, do not introduce modern technical solutions based on the utilization of light-weight structures and sections with high operating properties into these plans.

Another thing is also significant. Tens of millions of tons of metal waste are annually formed in the national economy. However, its collection and processing in many regions have been organized wretchedly. The Ukraine shows an example of skillful utilization of secondary resources. The goal-oriented scientific and technical Metall program developed here is of an

intersectorial nature and helps to implement a resource saving policy successfully. This experience deserves the broadest dissemination. After all, every ton of metal waste in steel smelting production replaces a ton of cast iron, which, in turn, saves about 30 man-hours of social labor.

Improvement in the quality of metal and a proprietary attitude toward its utilization are important components of the process of production intensification. In order to attain a decisive turning point in it, one cannot do without a thorough reconstruction--in thinking and psychology, in organization, and in the manner and method of work. They should take place in every labor collective. If it is a question of a production worker, he should ensure discipline and organization in work, a high productivity, and a high quality of output and guard what is at his disposal. If an engineer or a scientist is involved, he is called upon to make the maximum contribution to the development of the sector's scientific and technical progress. If it is a question of a worker in the sphere of management, his obligation and direct duty are to ensure the utilization of new methods of management and a prompt solution of all problems, on which final results and production efficiency depend. To raise the production and consumption of metal to a qualitative, new level means to make a substantial contribution to the strengthening of the economy of the Land of the Soviets.

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IMPREGNATION OF CAST IRONS WITH CHROMIUM AND ALUMINUM BY DIFFUSION

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 6, Jun 86 pp 23-25

[Article by V. I. Krayevoy, Belorussian State Institute of the National Economy]

[Abstract] Diffusion coatings on gray iron and high-strength cast iron (2.7-3.6% C, 2.0-2.8% Si, 0.5% Mn, 0.05-0.08% P, 0.02-0.08% S) were produced experimentally by impregnation with either chromium alone or with chromium and aluminum, for a structural examination and a comparative evaluation of their properties. The treatment involved adding powder, ferrochromium Kh70 or a mixture of ferrochromium Kh70 and APS-1 aluminum in varous ratios (A1:Kh70= 1:11, 1:5, 1:3), at a temperature of 1000°C for various lengths of time with Al_2O_3 as neutral additive and NH_4Cl as activator. For reference, the same treatment was applied to specimens of commercially pure iron and of U8 steel. Hardness measurements revealed and microstructural examination as well as x-ray phase analysis confirmed a dependence of the diffusion layer thickness on the impregnant composition and on the length of impregnation time. The rate of buildup of a diffusion layer was found to depend on the carbon content in the base metal with, accordingly, the thickest layer forming on commercially pure iron and the thinnest layer forming on high-strength cast iron in the same time under the same conditions. While layers of chromium carbides $Cr_{23}C_6$ and Cr_7C_3 without an underlayer of Cr-in-Fe_α solid solution had formed during plain chromizing, both structure and phase composition changed upon addition of aluminum. Chromoaluminizing had produced a coating of aluminides alloyed with chromium, no $FeAl_3$ because of the A1 content, only Fe_2Al_5+ Cr at the surface and a FeA1+ Fe_3Al superstructure or ordered solid solution with Cr underneath eventually becoming a solid solution of A1 and Cr in Fe_α. Structural changes were also found to occur during heat treatment, typically at 950°C for 50 h, particularly in the α-phase solid solution. Oxidation and scaling tests have yielded results which indicate that chromoaluminizing protects all four materials much better than plain aluminizing. References 1: Russian.

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PROBLEMS AT TAJIK ALUMINUM PLANT

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 10 Apr 86 p 2

[Article by SOTSIALISTICHESKAYA INDUSTRIYA special correspondent Ye. Leontyeva: "Scientific Illusions"]

[Text] 1. AN EMERGENCY SITUATION

"And now you will see the tomorrow of the aluminum industry. The latest technology, the last word, so to speak...."

The director of the institute, Doctor of Technical Sciences N. Kaluzhskiy, with a gesture of a host, pointed to the building that could be seen not far away. Glancing at him sullenly, the plant director M. Sinani spoke with bitterness:

"Let the 'last word' speak for itself."

Having donned helmets, we went down from the administrative building. Both directors were still flushed; prior to this they had spent nearly half the day carrying on a serious conversation in the office about who was right and who was at fault, about the sense of responsibility, and about the ability to admit mistakes. First one, then the other would dash up to the plant chart hanging on the wall and begin to move the pointer over the long rows of shops. The argument had been going on for some time, and no end was in sight.

The Tajik Aluminum Plant was situated on a most beautiful site. Ahead, to the right, and to the left were mountains whose snowcapped peaks breathed freshness and rest. But there was one characteristic detail; heading from Dushanbe towards the plant you could feel its presence. Ahead, the outlines of the mountains begin to lose their clearness, as if running into a greenish haze. Where does this screen come from? It is all very simple, Sinani explained, just as we entered one of the new structures. Instead of going to the powerful purifying plants, the gas drifts through the shop and goes into the atmosphere through the open doorways.

In this shop, aluminum is produced in electrolyzers--huge vats 60 meters long. Anodes--heavy "ingots"--are suspended over them, each weighing a ton. A pile of these heated "ingots" towered at the entrance.

"These all fell in one night?" Sinani asked one of the workers.

"One night," he confirmed.

The unexpected breaking of anodes and their falling into the vat is an emergency situation. Try to remove them from the 1000-degree melt. This requires incredible efforts of the crane operators.

"Sometimes as many as 20 or more fall in a shift," the plant director shakes his head. "We quench the bath and stop the process."

Having taken the initiative from Kaluzhskiy once and for all, who clearly did not like such explanations, he led us further to the lower floor of the shop. It is difficult to describe the spectacle confronting us. The huge span, wherever you looked, was immersed in hardened aluminum. This was the result of the "reliability" of the vats. The bottom of first one and then another would suddenly move from the walls, and then red hot metal would rush here in a hot stream.

The farther we went, the more weighty the arguments of one director became, and the hasty excuses of the other lost their basis. It was indeed hard to make excuses. The 2 years of operation of the new shops had convincingly shown that all the main assemblies of the electrolyzers proved to be inoperative. Things were no better with the automated process control system (ASUTP), without which the new production facility loses its principal advantage.

It is characteristic that the process itself of making aluminum in superpower electrolyzers using fired anodes has nothing to do with it. It long ago successfully earned itself a place in world industry, since it makes it possible to reduce the consumption of electrical power and raw material and to obtain a higher quality of metal. In addition, it makes it possible to automate the process and make it ecologically clean. All this is in comparison to the previous production process where self-roasted anodes were used.

But why is a process, long ago proven in world practice, proceeding so aimlessly in Tajikistan? Why does the plant incur such great losses? It lost 33 million rubles the year before last, and 48 million rubles last year. It is not likely they will decrease appreciably this year either. Add to that the tens of millions of rubles worth of fines for breaking contract deliveries, for over-consumption of electrical energy, and for low quality of metal. There is a reason that a bitter joke emerged in these parts, saying that the local aluminum is more expensive than the gold in the Zervashan valley.

Back about 1 year ago, there was one opinion: the plant's collective was at fault--the workers and specialists did not know how to operate the newest promising equipment and did not observe production discipline. What is interesting is that this version was thrust with enviable persistence everywhere by the All-Union Scientific Research and Design of the Aluminum, Manganese and Electrode Industry (VAMI), the head institute of the aluminum industry (whose director we just met). In 1983-1984, under a project of this institute, structures with superpower electrolyzers rated at a current of 255 kilo-amperes were set up near the city of Tursunzade. "Tomorrow," "A Bold Step in the Future," "New Generation"--what epithets did the scientists not endow upon the newborn shops.

But the epithets did not prove to be correct--the new generation of electrolyzers immediately showed their worst side. What is the matter? A steady stream of commissions flowed to the plant and checked, clarified, and double checked. But the VAMI was the main accuser each time, and in some way or other its position was visible through all the conclusions in the most unambiguous manner.

The best specialists of the sector were sent to Tajikistan in brigades and one at a time; one after another attempts were made to "straighten" the plant out. But the situation did not improve. At the June CPSU Central Committee meeting on speeding up scientific and technical progress, there finally was sharp criticism directed at the VAMI, thanks to which the mask of infallibility was removed from the face of the legislators of the sector's progress. Commissions again went to the Tajik Aluminum Plant; their conclusions differed from the earlier ones. In the first month the serious mistakes and major miscalculations of the head institute already appeared.

One-half year after the "turning point" of the meeting of the collegium of the Ministry of Nonferrous Metallurgy, held following the conference at the CPSU Central Committee, I went to Tajikistan where I saw the scene with the falling anodes and the leaking baths. The plant workers complained that there was one emergency situation after another. No one here expressed any hope that the plant would soon be on its feet.

"What do you think of the situation at the Tajik Aluminum Plant now?" I asked N. Kaluzhskiy.

"The work is not finished," he waved. "Give me another 2-3 years and the enterprise will be the best in the sector."

To tell the truth, I was surprised at such a light assessment faced with the obvious facts. But the director of the head institute very much liked using the vague, indistinct words "unfinished work," and he persistently held on to them. We all have unfinished work somewhere. Is that a great sin? But, they say, the plant must work more seriously on this, and on another, and another... Familiar tune, is it not?

"There is no arguing that the Tajik Aluminum Plant collective has something to work on: It must train its personnel more efficiently as well as improve production discipline," M. Zukhurtdinov, the plant's party committee secretary expressed his opinion concerning this. "Nevertheless, I say with all responsibility that under the conditions in which we have been placed, the collective is working selflessly, not receiving bonuses and not demanding gratitude."

Candidate of chemical sciences Zukhurtdinov previously headed the plant's technical department and knows it inside out. He also worked at the VAMI, but

soon understood that, as he says, there was "nothing for him to do" there. Taking over his duties 2 years ago, the first thing the young party organizer did was to visit related enterprises of the Urals and Siberia, study the experience of party work there, and get into the essence of technologies of older plants.

"Time itself promoted this person," M. Sinani said of the party organizer. Yes, a plant getting on its feet needed just such a person who, sparing no efforts, would defend its good name and not give in to the authority. Kaluzhskiy and Zukhurtdinov seemed to oppose one another. The clash of their opinions, it seemed, was on the verge of striking sparks. Even where Sinani, having recently taken up his post, tried to smooth over and soften the sharpness of the contradictions, Zukhurtdinov refused to compromise. There have been enough half measures and all sorts of partial improvements, he convincingly argued. You will not go far with that. . What is needed are fundamentally efforts, would defend its good name and not shirk authority. Kaluzhskiy and Zukhurtdinov seemed to oppose one another. The clash of their opinions, it seemed, was on the verge of striking sparks. Even where Sinani, having recently taken up his post, tried to smooth over and soften the sharpness of the contradictions, Zukhurtdinov refused to compromise. There have been enough half measures and all sorts of partial improvements, he convincingly argued. You will not go far with that. What is needed are fundamentally different design solutions, a new, higher level of research work, bold thinking, and promising ideas.

"Incidentally, at the plant we have such thoughts and ideas. If you want to see a person who not only differs with the VAMI in his views, but also opposes it creatively,, meet Andrey Ivanov," the party organizer advised me.

I had heard about Ivanov as soon as I arrived at the plant. One of the metallurgists called him the "people's doctor." The "nickname" stuck in my mind, and its origin became clear after I became familiar with the production facility. The results of "doctoring" of the engineer-mechanic known to the entire collective were apparent everywhere. Wherever solutions of the VAMI failed, he would rush to give first aid, find at least a temporary alternative, and "patch" them up.

"You know, I am so tired of patching up that I'm even becoming angry," Ivanov admits. "So I made up my mind to solve the problem in my own way, and not as they do it at the VAMI."

Right at the plant he conducted a series of scientific studies and developed a new bath, a new system for inputting current, and his own automation. In other words, he completely built an electrolyzer of an absolutely new design. As the inventor says, this is something like a robot which services itself and nourishes itself. Incidentally, he has made not one, but two different designs of electrolyzers.

I tried to find out from Kaluzhskiy how the VAMI assesses Ivanov's work.

"Do you want to compare an entire institute with some innovator?" he grinned. You had better come to visit us in Leningrad. I am sure your opinion will change."

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LEADERSHIP OF ALUMINUM INSTITUTE QUESTIONED AT MEETING

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 14 Jun 86 p 2

[Article by Ye. Leontyeva: "Ministry-Produced Illusions"; passages rendered in all capital letters printed in boldface in source]

[Text] WHY THE BOARD OF THE USSR MINISTRY OF NONFERROUS METALLURGY DID NOT SUFFICIENTLY PROBE THE ERRORS OF THE LEADING INSTITUTE.

"It is time to finally admit it: we have reached a deadend. It was the leading institute of the aluminum industry that led us there--this is now clear to everyone. But, what is not clear is where do we go now?"

After these words of the First Deputy Minister L. Kozlov, a tense silence descended over the board room: the specialists sitting here were unable to say with full assurance which decision in this situation will minimize losses the most.

It was not a slip of the tongue on my part: VAMI [All-Union Institute of the Aluminum, Magnesium and Electrode Industry] which was the subject of the article "Science-Produced Illusions" (SOTSIALISTICHESKAYA INDUSTRIYA, 10 and 11 April 1986) in fact did not leave the Ministry of Nonferrous Metallurgy any other way out than to go backwards. The only question was how and by how much.

In recent years, according to developments of the Institute, three generations of powerful electrolyzers were put into operation one after the other--160, 175 and 255 kiloamperes. They were put into operation hurriedly: without testing and immediately on a large industrial scale. And, each following generation has been operating more poorly and less safely than the preceding one.

The last lesson to be learned, as related at the meeting, were the accidents in the new wing of the Sayansk Aluminum Plant. Here, VAMI offered to set up a modernized series of electrolyzers. The developers insisted that in this series the errors and miscalculations, allowed in earlier designs, had been taken into account. However, a half year had not passed when fiery rivers flowed--breaks in the metal started. The situation, which has ailed and continues to ail the earlier built Tajik aluminum plant, has repeated itself.

And now, employees of the ministry, managers of enterprises, and specialists--all who have been gathered into the board room for advice--have to solve a complicated problem: what next? Although a draft decree already exists, the arguments do not die down. Much of what had been planned foolhardily without close examination has to be planned all over again. Which machine units should be given preference? Some believe that it is better to go back by one generation of electrolyzers, others believe by two generations. As for "last word" science--machine units for 225 kiloamperes--no one even talks about them now.

...Though the meeting started very sharply, nevertheless, it was eventually on the production track as usual. Of course, an acceptable way out of this situation is essential. And, as soon as possible. Is this the only matter to be discussed? No less important is another matter--how to eradicate those causes that led to the present state of affairs? To do this, the causes have to be found first, exposed to the light of day, and thoroughly analyzed. One can hardly speak about radical changes without doing this.

"We always believed the VAMI directors, and did as the leading institute recommended," admits L. Kozlov. "How could we not believe them, after all they have gone around the world, no one has travelled as much. Who, if not they, should know the state of world metallurgy?"

But, why were the lawmakers of industrial policy believed for so long and so willingly when already for a long time there were no grounds for this? Every time an extraordinary event occurred in production, VAMI Director and Doctor of Technical Sciences N. Kaluzhskiy with his characteristic self-confidence continued to convince everyone that the institute developments are reliable and the failures are due to extraneous causes. He maintained that within a short time we will be assured of priority among the most developed countries. But, the words of the director proved to be as insubstantial as the last technical decisions of the institute in the area of aluminum electrolyzers. Their present cost is about 300 million rubles out of the state's pocket. However, what is more serious is the lost time. That which is priceless is irreplaceable.

"We are guilty," agrees L. Kozlov, "all of us are guilty: the minister and his deputies, the administration managers, and VPO Soyuzalyuminiy [Aluminum Industry Industrial Association]...

When all are guilty, then no one is. Responsibility is dissipated and, as a result, there is no one to question. But, the levels of competence are quite specific; a comparison with these levels makes it fairly easy to find the guilty parties.

Actually, the institute reports directly to Soyuzlyuminiy, which is directed by B. Zlokazov and where M. Zaytsev is chief engineer. Why with their staff did they calmly watch the growing trouble and why did they sign decrees, which were passed without thinking and in a hurry?

"VAMI misled us and tried to prove that all problems had been solved," explained B. Zlokazov, who happened to be standing nearby.

It sounds naive, doesn't it? The VPO, which should have been directing the work of the institute, was just following while production was ailing because of failure. The question is: aren't there any specialists, capable of assessing work in this field, in Soyuzalyuminiy? Isn't Soyuzalyuminiy able to enlist the institutes of the USSR Academy of Sciences and the VUZES in the solution of problems? Incidentally, these institutions have their own interesting solutions and ready developments that have caught the eye of Academician A. Aleksandrov, president of the USSR Academy of Sciences, more than once. But, you see VAMI looks upon competitors with disfavor. And, all these years the VPO has been supporting the monopolistic ambitions of the institute.

Let us assume that the administrators of Soyuzalyuminiy were wallowing in a mire of production troubles. But, the Ministry of Nonferrous Metallurgy has a scientific and technical administration, which A. Snurnikov headed for a long time, and now--A. Golubev. Seemingly, it would be precisely this administration that should have been fighting for technical progress in the first place. However, the administration employees have their own "special" opinion on this subject. Their main argument is that "the institute does not report to us, but to Soyuzalyuminiy." So, it is the one to be questioned they say.

Here is an interesting detail that tells us much. During the meeting the administration employees appeared as if they were not a part of the heated discussion: they did not participate in the talks and no one appealed to them. The impression given was that the scientific technical administration plays more than a modest role in the ministry.

Let us go up one more rung. Deputy Minister I. Prokopov curates the aluminum industry. When asked what the causes were of the present crisis situation, he replied in his already familiar tone: "But, you know, the institute reports to Soyuzalyuminiy."

I asked I. Prokopov to break down the following into its simplest terms: who and at what stage bears responsibility for new technology --from development to its industrial assimilation. All the following appeared in the answer: the institute, VPO, the plant, and the ministry administrations of the chief power engineer, chief mechanic and capital construction. However, the scientific-technical administration did not appear in the listing. Also, not a word was said about the curator's responsibility.

It is true that the person I was talking to [I. Prokopov] tried to prove that the ministry staff "had its finger on the pulse" of new technology. The staff made many decisions concerning the construction of experimental bases, testing of machine units, improvement

of designer work, strengthening of the plant science sector... They discussed all this at board meetings a number of times, gave orders and issued decrees. (If the ministry were given an opportunity to account for its paperwork, the report would probably be excellent). But, what is their value? We can only judge by the end result. And, this we know.

K. Arbiyev, another deputy minister, expressed himself on this matter more specifically: "Plenty of decisions were made, but they did not make much sense. Let's ask ourselves: on what grounds did we make them? We made them in a resolute manner without any comprehensive technical approach and without any scientific basis. On sheer trust."

There is no argument. One has to have trust. Particularly in the case when each on HIS level reliably carries out HIS functions. But, at the Ministry of Nonferrous Metallurgy, judging by everything, they did not simply have trust, but ENTRUSTED the strategy of the subsector to one institute, which turned down all kinds of competitive proposals from the "outside". Isn't this position of the ministry akin to conveniently removing one's self from the important and complex problems of scientific-technical progress? From the problems, which should reliably provide for a long-range plan and not only for today's plan?

The troubles of the plan could not but place their stamp on the decision made by the board. The course of the discussions was such: if we return to the electrolyzers for 160 kiloamperes, we will win in production stability and metal quality. If we return to the 175 kiloampere electrolyzers, we will produce more aluminum. And, more aluminum is more impressive, even though it is not the metal that many important sectors of the national economy need.

"It is still questionable whether we will produce more," were the objections that were heard. Actually, there is no such electrolyzer, there isn't even a scientific basis for its development. Again, we are clingirg to sheer promises...But, the decision has been made: for a 175 kiloampere electrolyzer, and not one step back!

Time will tell how sound this decision was. But, I want to say something else. Any metallurgist knows that aluminum may be produced not only by electrolysis of melt. Why are we so stubbornly pulling only one strand from a number of potential ones? Only because there are tens of years behind the industrial use of the electrolytic process? The evolution of technology takes a long time and is not highly efficient. We need radical changes.

There are alternative proposals--plasma, electrothermal, and chlorine methods of producing aluminum already exist. There are others--in theory, there are many. Can it be that here, along other pathways, tremendous potentialities are hidden? But, these methods have not reached the industry. It is not surprising that all the maneuvering

now has to take place within one variant. However, to calculate and check everything ahead of time and to rise to the heights of foresight, based on a profound knowledge of world practical experience, there has to be a way out from under the sea of paperwork and concerns of the moment. A different, more thoroughly thought out, precise system of controlling scientific-technical progress in the sector is essential. An entirely different level of responsibility is needed--professional and public. And--party. In the meantime, neither the partkom of VAMI nor the partkom of the Ministry of Nonferrous Metallurgy gave a basic assessment of what had happened in time. It is true that after the article appeared in the paper the guilty parties were punished. But, only in the administrative line.

The board meeting which lasted many hours came to an end.

"What do you think? Can Kaluzhskiy be trusted to head the institute? Can he take the main direction of development in the aluminum industry even further?" L. Kozlov asked those who were present.

"If you will trust me, I will manage!" asserted Kaluzhskiy.

"We will trust you!"

12525/12947
CSO: 1842/216

UDC 621.315/592

BINARY DOPING OF GERMANIUM SINGLE CRYSTALS AND RESULTING DISTRUBUTION OF IMPURITIES

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 1, Jan-Feb 86 (manuscript received 16 Oct 84) pp 84-89

[Article by V. A. Kuznetsov, D. I. Levinzon, and A. V. Inozemtsev]

[Abstract] Simultaneous doping of germanium single crystals with two acceptor impurities is studied, the purpose being to demonstrate the feasibility of equalizing the charge carrier concentration. The two impurities with concentration profiles differently depending on the fraction of crystallized melt are boron crowding toward the front of the ingot and gallium crowding toward the back of the ingot. Theoretical calculations of the apparent boron and gallium distribution factor, which depends on the rate of crystal growth and on the ratio of gallium concentration to boron concentration in the melt, are supported by experimental data including measurements of the electrical resistivity. Single crystals were grown at rates of $(2.5\text{-}3.3\text{-}4.1)\cdot10^{-5}$ m/s and the ratio of gallium concentration to boron concentrations was varied over the 8.6-43 range. The results reveal that the electrical resistivity averages along the crystallized portion of the melt, this average corresponding to the fraction of melt which has crystallized. A uniform distribution of total charge carrier concentration along the single crystal is attainable with a certain ratio of gallium concentration to boron concentration which varies depending on the fraction of melt already solidified. The apparent impurity distribution factor remains constant as the crystal growth rate is varied over the given range and the ratio of gallium concentration to boron concentration is varied proportionally. References 13: 9 Russian, 4 Western (1 in Russian translation).

2415/12947
CSO: 1842/219

UDC 669.715.017

ALLOYS OF A1-Zn-Cu SYSTEM

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 1, Jan-Feb 86 (manuscript received 18 Sep 84) pp 90-94

[Article by G. M. Kuznetsov, G. B. Krivosheyeva, V. Ye. Dolgova, and L. A. Rassadina, Chair of Physical Metallurgy of Nonferrous, Rare, and Radioactive Metals, Moscow Steel and Alloys Institute]

[Abstract] A study of cast ternary aluminum alloys in the A1-Zn-Cu system was made, with the Zn content and the Cu content each varied up to 20 atom.%, for the purpose of determining the phase equilibria as well as the solidus, the liquidus, and the solvus of the α-phase. The alloys were produced from A99 aluminum, TsO Zinc, and M00 copper. The constitution diagram with liquidus surface and solidus surface as well as polythermal (A1+ const. Zn)-Cu profiles for the 0-20 atom.% Zn, 0-20 atom.% Cu region of the system have been constructed on the basis of data pertaining to 27 different alloys. These data were obtained as a result of examination under a Neophot-2 microscope, x-ray structural and phase analysis in a DRON-2 diffractometer with Cu-line radiation, thermal analysis by the method of chemical thermodynamics, assuming equal chemical potentials of components in phases of a ternary alloy at biphase equilibrium, and phase equilibrium calculations. The three thermal effects in a binary eutectic were found to correspond to its liquidus temperature (T1), beginning of crystallization (T2), and end of crystallization (T3). References 8: 6 Russian, 2 Western.

2415/12947
CSO: 1842/219

UDC 669.2

HYDROMETALLURGICAL PURIFICATION OF MAGNESIUM-THERMAL REACTION CHARGE WITH TITANIUM AND LOW REDUCER CONTENT

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 1, Jan-Feb 86 (manuscript received 11 Feb 85) pp 123-124

[Article by A. D. Dunayev, V. A. Likhterman, Ye. P. Terenin, Yu. M. Chashchinov, and B. G. Vorotinova, Leningrad Mining Institute; Moscow Steel and Alloys Institute]

[Abstract] Production of titanium sponge by the thermal process with use of magnesium as reducer is considered, methods being sought for intensifying the depletion of residual chlorine during hydrometallurgical purification of the reaction charge. The chlorine ion is known to appear in the form of salts, $KMgCl_3.6H_2O$ or $MgCl_2$ and possibly KCl, its residual concentration increasing with increasing dose of magnesium. Ultrasonic treatment for 20 min and lixiviation with an acid such as 10% HNO_3 or 10% HCl for 24 h have been found to lower the residual Cl^- concentration in titanium sponge to 0.15 wt.%. Ultrasonic treatment in this study was applied at a frequency of either 21.7 kHz or 17.9 kHz, with a power density of 10-50 kW/m^2 under a pressure of 3.2 atm. References 3: all Russian.

2415/12947
CSO: 1842/219

UDC 669.74'71'784:621.77.016.2:538.22

DYNAMIC RECRYSTALLIZATION, SUPERPLASTICITY, AND MAGNETIC PROPERTIES OF MnA1-C ALLOY

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 61, No 5, May 86 (manuscript received 19 Jul 85) pp 884-892

[Article by A. V. Shangurov, M. A. Uymin, A. Ye. Yermakov, and Ye. I. Teytel, Metal Physics Institute, Ural Science Center, USSR Academy of Sciences]

[Abstract] A study of the 69.5% Mn - 30% A1 - 0.5% C alloy was made, for the purpose of determining its structure and magnetic properties during hot deformation. The alloy was produced by smelting MR-0 manganese and AV-00 aluminum with spectrally pure graphite in an argon atmosphere in an induction furnace. Ingots, after homogenization at 1150°C for 2 h into the ε-phase with a c.p.h. crystal lattice, were first cooled in a molten-salt bath to 560°C and 1 min later in air for almost complete transformation into the ferromagnetic τ-phase. Cylindrical specimens 5-9 mm in diameter and 5-10 mm high were deformed by hot upset forging at 500-600-700°C at a rate of 0.5 mm/min in a UME-10TM testing machine, those deformed at 700°C being immediately afterwards cooled with a water jet. One rod specimen was deformed at 700°C at a strain rate of $1.6 \cdot 10^{-3}$ s^{-1} to a 25% deformation and then cut into 4 mm long segments of 5 mm in diameter. These were subjected to free setting at 700°C and 750°C in the same UME-10TM machine with the rate varied over the 0.01-50 mm/min range and in a plastometer at strain rates of 1.5-20 s^{-1}. The microstructure was examined under an "Epiquant" microscope and under a BS-540 electron microscope. The magnetic properties, namely coercive force and maximum as well as residual specific magnetization characterizing the hysteresis loop, were measured with a vibratory magnetometer in a magnetic field up to 2.2 MA/m strong. The results indicate that hot deformation of both cast alloy and recrystallized alloy within the given temperature range and strain rate range is attended by dynamic recrystallization rather than by dynamic recovery and subsequent static recrystallization, with formation of superfine grains smaller than 1 μm characteristic of superplasticity without dislocations and twinning. The authors thank G. M. Makarova for performing the x-ray analysis, G. N. Suntsov and G. V. Belalova for assisting in the plastometer tests, and V. I. Levit for participating in the discussion of the results. References 12: 7 Russian, 5 Western (1 in Russian translation).

2415/12947
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UDC 669.15:539.213:538.22

MAGNETIC PROPERTIES OF AMORPHOUS Fe-Co-Si-B ALLOYS WITH VARYING BORON CONTENT

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 61, No 5, May 86 (manuscript received 12 Jul 85) pp 893-897

[Article by A. A. Glazer, A. P. Potapov, and Ye. V. Belozerov, Metal Physics Institute, Ural Science Center, USSR Academy of Sciences]

[Abstract] A study of amorphous magnetically soft alloys in the Fe-Co-Si-B systems was made, for the purpose of determining the effect of small differences in the boron content on the magnetic properties including the hysteresis loop. Five alloys $Fe_5Co_{80-x}Si_{15}B_x$ with 8,9,10,11,12 atom.% B respectively were produced in an argon atmosphere in an induction furnace, their composition being monitored by weight analysis. Amorphous ribbons 30 μm thick and 3 mm wide were produced from ingots by fast quenching, to be cut into toroidal specimens weighing approximately 0.7 g each. These were annealed at temperatures of 300-475°C for 1 h at each, in a magnetic field of 1 kA/m intensity and without one. Their quasi-static hysteresis loops were measured by the ballistic method with an F-190 microwebermeter. Their Curie point was determined during heating as the temperature at which the 50 Hz hysteresis loop, monitored on an oscilloscope, vanished. The results reveal that the temperature at which crystallization begins and the Curie point depend on the boron concentration, the former becoming slowly higher and the latter becoming rapidly lower as the boron concentration increases, while the coercive force and the ratio of residual to maximum magnetic induction depend on the boron concentration as well as on the annealing temperature. The measurements have also revealed a uniaxial magnetic anistropy induced by annealing in a magnetic field with subsequent slow cooling to room temperature, this anisotropy becoming weaker as the boron concentration increases. Annealing without a magnetic field induced such an anisotropy, too, with stabilization of domain walls. Absence of this anisotropy and consequently of the stabilization effect in alloys with high boron concentration indicates a low sensitivity of their magnetic properties to low-temperature annealing without a magnetic field. References 7: 3 Russian, 4 Western (1 in Russian translation).

2415/12947
CSO: 1842/221

UDC 669.861'1'25:538.652

MAGNETOSTRICTION IN SINGLE CRYSTALS OF INTERMETALLIC COMPOUNDS WITH RARE-EARTH ELEMENTS SUCH AS $Er_2(Co_{1-x}Fe_x)_{17}$

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 61, No 5, May 86 (manuscript received 23 Jul 85) pp 898-903

[Article by N. V. Kudrevatykh, Ural State University imeni A. M. Gorkiy, E. W. Lee and D. Melville, Southampton University (UK)]

[Abstract] Magnetostriction in intermetallic compounds $Er_2(Co_{1-x}Fe_x)_{17}$ was measured over the 5-293 K temperature range, for the purpose of determining both its temperature dependence and field dependence. At each temperature magnetic pulses of 10 ms duration and up to 12.8 MA/m intensity were applied to single crystals of six compounds with x= 0.0 (Er_2Co_{17}), 0.2, 0.4, 0.6, 0.8, 1.0 (Er_2Fe_{17}) respectively, these single crystals being 1.5-2.0 mm long in the [001] direction (c-axis) or in the [100] direction (a-axis). Magnetostrictive strains were measured with "Micromeasurements" SK-09-031-350 microstrain gages. Only the largest magnetostriction constant $\lambda_2^{\alpha,2}$ was determined, this constant being equal and of opposite sign to the saturation magnetostriction constants $\lambda^s_c = \lambda^s_{bc}$ in compounds with the axis of easy magnetization parallel to the c-axis and equal to the magnetostriction constant λ_{cc} in compounds with the axis of easy magnetization perpendicular to the c-axis (s denotes saturation, first index denotes crystal axis, second index denotes direction of strain measurement). The results, interpreted in accordance with the theory of magnetostriction in uniaxial single crystals, reveal that the Er sublattice and the 3d-ion sublattice are magnetostrictively strained in opposite directions during magnetization in the difficult direction. The experimentally determined temperature dependence of $\lambda_2^{\alpha,2}$ for compounds with x= 0.6 and x= 0.8 agrees closely with the theoretical model of single-ion magnetostriction in Er, while the field dependence of λ_{ac} for compounds with $x \geq 0.4$ agrees closely with the theoretical model of coherent rotation of the magnetization vectors in both Er and 3d sublattices in the difficult direction, with $\lambda_{ac}(H) = -\lambda_2^{\alpha,2}[M_a(H)/M_s]^2$. The results reveal also a spin-orientational phase transition induced by a magnetic field in single crystals with x=0.6-0.8 and manifested by a steep jump of the $\lambda(H)$ curves. References 13: 9 Russian, 4 Western.

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UDC 621.315.592:539.211

EFFECT OF SURFACE TREATMENT ON ULTIMATE STRENGTH OF MONOCRYSTALLINE SILICON

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 86 (manuscript received 25 Jun 84) pp 98-101

[Article by V. B. Osvenskiy, B. M. Turovskiy, L. A. Zhukova, M. V. Mezhennyy, Ye. L. Sokolova, and O. G. Stolyarov, Moscow]

[Abstract] For the purpose of determining the effect of surface treatment on the ultimate strength of monocrystalline silicon, n-Si single crystals with an electrical resistivity of approximately 10 ohm.cm were grown by the Czochralski method, variously doped, and cut into 0.8-0.9 mm thick plates. These plates were on both sides ground with M-28 SiC powder, then chemically polished and etched in HNO_3:HF= 2:1 concentrate for removal of the defective surface layers 180-200 μm deep as verified by electron-diffraction analysis. They were tested after each operation in "soft" axisymmetric flexure, with the maximum deflection larger than half the thickness, by contactless loading in an "Instron" machine. The silicon single crystals had been either lightly or heavily doped with boron ($5 \cdot 10^{14}$ cm^{-3}, $2.5 \cdot 10^{19}$ cm^{-3}), phosphorus ($9 \cdot 10^{15}$ cm^{-3}, $2 \cdot 10^{18}$ cm^{-3}), or gallium ($1 \cdot 10^{15}$ cm^{-3}, $3 \cdot 10^{18}$ cm^{-3}). The wide variance of strength after grinding may have been caused by residual SiC microcrystals adhering to the surface. The test results with a satisfactory reproducibility after chemical polishing indicate a consistent increase of strength, that of lightly doped silicon to 6 ± 0.65 GPa and that of heavily doped silicon to 9.37 ± 1.05 GPa. References 10: 6 Russian, 4 Western.

2415/12947
CSO: 1842/220

UDC 669.782:539.4.016.2

COMPREHENSIVE STRUCTURAL ANALYSIS BY X-RAY DIFFRACTION OF SILICON LAYERS MADE DEFECTIVE BY CUTTING

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 86 (manuscript received 16 Jul 85) pp 122-125

[Article by M. G. Milvidskiy, V. G. Fomin, M. M. Khatskevich, N. M. Pavlov (deceased), L. A. Shchetolkova, and B. L. Meyler, Moscow]

[Abstract] Silicon layers made defective by mechanical treatment were studied by three methods of x-ray diffraction analysis providing together comprehensive data on the crystal structure and stresses as well as on all types of defects. The specimens for this study were 450 μm thick (111) wafers cut from a Si<Sb> single crystal with a [111] axis and 75 mm in diameter. They were layerwise etched with a $HF:CH_3COOH:HNO_3$ = 2:4:9 mixture on one side, the other side having been coated with KhSL varnish. A small area on the defective surface was also coated with this varnish prior to etching. The half-width of diffraction-peak oscillation curves was measured with a bicrystal spectrometer using a CuK_{α_1}- radiation source, the crystals in (1,-1) position. The curvatures of crystallographic planes were measured with a bicrystal spectrometer using a CuK_{α_1} source and a CuK_{α_2} source, the crystals in (4,-4) position. Local defects of crack and dislocation types were detected by the Lange method of transilluminating diffraction topography with a MoK_{α_1}-radiation source and also under a transmission electron microscope. The results reveal a trizonal structure of the defective layer and confirm the sensitivity of each method to different types of defects. They will be useful for optimizing the technology of semiconductor devices. References 18: 11 Russian, 7 Western (2 in Russian translation).

2415/12947
CSO: 1842/220

UDC 621.315.592:621.373.826

EROSION OF SEMICONDUCTOR SURFACE DURING LASER TREATMENT

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 86 (manuscript received 17 Jan 84) pp 132-134

[Article by A. A. Uglov and A. V. Kornilov, Moscow]

[Abstract] Erosion of the semiconductor surface during laser treatment was studied in an experiment using a YAG:Nd pulse laser with transverse pumping and acoustic Q-switching in the TEM_{00}-mode. The specific semiconductor material selected was silicon, polished KDB and KEF silicon plates being most suitable for laser treatment. The pulse duration was varied over the 100-200 ns range and the pulse repetition rate was varied up to 10 kHz, the maximum pulse energy being approximately 5 mJ. The power density within the treatment zone was varied over the $5 \cdot 10^7$-10^9 W/cm^2 range by defocusing of the objective, two objectives with 50 mm and 100 mm focal length respectively having been used here. The dependence of the beginning of erosion on the energy characteristics of focused laser radiation was determined from measurements of the intensity of radiation diffusely scattered by the semiconductor surface. These measurements have yielded a saddle point at zero defocusing between two peaks of that intensity at a certain magnitude of forward and backward defocusing. An explanation for this is increased shielding of the photodetector by an ion cloud forming above the overheated semiconductor melt surface as the laser power density increases. The results indicate the optimum range of laser power density for erosion control within the treatment zone. They also indicate that the best cut, minumum width and maximum depth, will be obtained with the semiconductor surface lying in the neck of the caustic surface of the optical focusing system. References 4: 3 Russian, 1 Western.

2415/12947
CSO: 1842/220

UDC 669.715

EFFECT OF IMPURITIES ON STRUCTURE AND MECHANICAL PROPERTIES OF CAST A1-Mg ALLOYS

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 1, Jan-Feb 86 (manuscript received 26 Nov 84) pp 94-100

[Article by V. S. Zolotorevskiy, V. V. Istomin-Kastrovskiy, Yu. N. Mansurov, and A. K. Tynishbayeva, Chair of Physical Metallurgy of Nonferrous, Rare, and Radioactive Metals, Steel and Alloys Institute]

[Abstract] In search of secondary cast A1-Mg alloys having properties comparable with those of primary ones, scrap and tailings were studied for the effect of impurities. Three pure A1-Mg alloys served as reference: 4% Mg (lower limit with respect to adequate castability and strength), 6% Mg, 8% Mg (upper limit with respect to adequate corrosion resistance and acceptable amount of brittle $A1_3Mg_2$ phase). All other 28 alloys were classified into low-impurity alloys (0.3% Si, 0.3% Fe, 0.3% Cu, 0.3% Zn, 0.3% Mn, 0.2% Ni, 0.1% Sn, 0.1% Pb), medium-impurity alloys (0.5% Si, 0.5% Fe, 0.5% Cu, 0.4% Zn, 0.4% Mn, 0.3% Ni, 0.2% Sn, 0.2% Pb), and high-impurity alloys (0.6% Si, 0.6% Fe, 0.6% Cu, 0.6% Zn, 0.6% Mn, 0.5% Ni, 0.3% Sn, 0.3% Pb). The effect of each impurity alone was studied on the 6% Mg alloy. All alloys were produced from A7 aluminum in a graphite-firebrick resistance furnace, with Mg, Cu, Si, Sn, Pb added in pure form under the melt surface and Fe, Ni, Mn added in the form of their alloys. The composition was monitored by chemical analysis. The melt was refined with hexachloroethane and then poured. All alloys were heat treated according to the T4 procedure for commercial primary A1-Mg alloys. Only the alloys with 8% Mg were quenched, after heating at 460°C for 4 h, quenching having a much more pronounced effect on them than on alloys with lower Mg content. The results of mechanical tests in tension reveal that addition of impurities in increasing amounts generally causes an appreciable decrease of plasticity (percentage elongation) and only a slight change in strength characteristics (ultimate strength, 0.2% yield strength, Brinell hardness), most detrimental being the impurities Si, Fe, Cu. Phase analysis under an MIM-8 optical microscope and under a scanning electron microscope with an "Ieol" ISM-35CF x-ray microspectrum analyzer has revealed five structural components: α-A1, Mg_2Si+(Sn,Pb), A1(Fe,Ni,Mn)+ traces of Cu, [α + $\beta(A1_3Mg_2)$] eutectic, [α + β + S($A1_2MgCu$) eutectic. The results indicate that adequate mechanical properties of these alloys with the given impurities within the given ranges

can be ensured by high-temperature heat treatment at 518±5°C for 10 h prior to quenching so as to facilitate partial dissolution of excess phases and deformation of Mg_2Si particles. References 8: all Russian.

2415/12947
CSO: 1842/219

UDC 549.2:533.9.539.211

LASER-PLASMA SYNTHESIS OF CARBIDES OF REFRACTORY METALS IN CARBONOUS MEDIA

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 86 (manuscript received 8 Aug 85) pp 3-8

[Article by A. A. Uglov, A. F. Gorbach, I. Yu. Smurov, L. I. Mirkin, and L. L. Krapivin, Moscow]

[Abstract] Carbides of metals in groups IV-VI were synthesized experimentally by action of laser plasma in high-pressure carbonous media. Neodymium lasers (wavelength λ= 1.06 μm) GOS-301, GOS-30M, and KVANT-16 were used for this purpose, with the pulse duration varied over the 1-5 ms range and the characteristic power density varied over the 10^5-10^7 W/cm^2 range. Carbides of Ti, Zr, Hf, Nb, Ta, Mo, W were produced by placing these metals in gaseous atmospheres of CO_2 (1-50 atm) or methane CH_4 (1-110 atm) or under a layer of liquid C_5H_{12}, heptane C_7H_{16}, toluene C_7H_8). The interaction zone and the layer of reaction products were examined by metallographic methods and under an electron microscope, microhardness was measured with a PMT-3 tester under 50 g and 100 g loads, x-ray phase analysis was performed in a DRON-2.0 diffractometer with Cu-line radiation and a filter. The results reveal formation of carbides and also oxides or oxycarbides, in a CO_2 atmosphere, the phase mix and the mechanical properties depending on the medium and the pressure as well as on the characteristics of the optical-breakdown plasma and thus on the laser pulse. During laser action on Mo and W in a CO_2 atmosphere the metal is shielded by laser plasma till its surface begins to melt or even longer, a hydrocarbon atmosphere therefore being preferable for synthesis of their carbides. Application of several successive laser pulses, say three, instead of only one was found to carry the synthesis farther and thus result in a surface layer containing more carbide and less free metal, with an attendant improvement of its mechanical characteristics. References 9: 7 Russian, 2 Western (1 in Russian translation).

2415/12947
CSO: 1842/220

UDC 669.725'75:536.421.4

COEFFICIENTS CHARACTERIZING DISTRIBUTION OF IMPURTIES DURING GROWTH OF InSb SINGLE CRYSTALS FROM MELT IN A MAGNETIC FIELD

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 86 (manuscript received 8 Aug 85) pp 64-67

[Article by V. S. Zemskov, M. R. Raukhman, D. P. Mgaloblishvili, Yu. M. Gelfgat, and M. Z. Sorkin, Moscow]

[Abstract] Single crystals of n-InSb were grown experimentally by the Czochralski method from a melt with Te, Cd, Zn impurities in a transverse magnetic field, for the purpose of determining the effect of a magnetic field on the distribution of these impurities during the growth process. The source material was pure n-InSb with an electron concentration $n \approx 10^{15}$ cm^{-3}, doped with a donar (Te) or acceptor (Cd,Zn) in doses of $(3-6)\cdot 10^{18}$ atoms/cm^3. Crystals were grown in the <100> direction, which eliminated the face effect, within a 90 mm wide gap between circular pole shoes of an electromagnet 90 mm in diameter. The material was first melted and then held at a temperature 30-40°C above the crystallization point for 30-40 min. The magnetic field was applied after seeding and maintained while the growing crystal was spun about its growth axis at a speed of 30 rpm in the stationary crucible. Crystals were pulled at a rate of 0.5 mm/min. The magnetic induction across the crystal in the gap could be varied over the 0-0.5 T range. The distribution of an impurity was determined in terms of the coefficient $K=C_c/C_m$, the impurity concentrations C_c in the crystal and C_m in the melt having been established by three methods of chemical analysis: inversion voltamperometry (A. A. Kaplin at the Tomsk Polytechnic Institute), atomic adsorption (G. M. Varshal at the Moscow Geochemistry and Analytical Chemistry Institute imeni V. I. Vernadskiy), and chemical spectrometry (V. P. Maltseva at the State Scientific Research and Planning Institute of the Rare Metals Industry). The error of analysis was 15-20% for Te, 10-15% for Cd and Zn. Calculations involving the Reynolds number and the Schmidt number as well as the Hartmann number for a diffusion layer in a magnetic field reveal that, as the magnetic induction in the growth zone is increased, the effective distribution coefficient K increases fast for Cd, increases slowly for Te, and decreases for Zn. These results agree with calculations based on theoretical analysis. Such a field dependence of the effective impurity distribution coefficient is evidently caused by changing thickness and impurity content of the diffusion layer at the crystallization front. References 15: 7 Russian, 8 Western (4 in Russian translation).

2415/12947
CSO: 1842/220

UDC 620.178.16:669.14.018.298

EFFECT OF CHEMOTHERMAL TREATMENT OF STRUCTURAL STEELS ON THEIR WEAR RESISTANCE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 6, Jun 86 pp 20-23

[Article by I. M. Rukina, Yu. A. Bashnin, V. L. Kozlov, V. G. Kaplun, and A. N. Utkina]

[Abstract] In an experimental study concerning frictional wear of case hardened heat-resistant steels, measurements were made by the micrometric method with an MKM ratchet head ($\pm$0.05 mm full scale with 0.001 mm divisions) and simultaneous recording of the moment of friction with a KSP-005 potentiometer in a special test stand built for this purpose. The equipment included a gear drive with roller-pinion, a spindle held in chucks, a table, and a friction mounting. With this equipment there were tested specimens of $12CrNi3N_2$, $20CrMoWVN_2$ (EI 475), and $16Cr2Ni3MoVBN_2A1$ ball bearing (VKS-7Sh) steels after concentration (930$\pm$10°C for 8 h), 2-stage cementation (930$\pm$10°C for 2 h + 900$\pm$10°C), or nitrocementation (900$\pm$10°C for 8 h), 2-stage nitrocementation (950$\pm$10°C + 900$\pm$10°C, 930$\pm$10°C + 870$\pm$10°C, 920$\pm$10°C + 870$\pm$10°C for 10 h) with subsequent tempering at 650°C for 3 h (omitted after nitrocementation at 900$\pm$10°C for 8 h and at 920$\pm$10°C + 870$\pm$10°C for 10 h) + quenching from 860-900°C + cryogenic cooling at -70°C for 2 h + tempering at 160-230°C for 3 h. Wear and friction were measured over the 0.9-1.3 m/s range of sliding velocity and the 1.5-6.0 N/mm^2 range of load pressure, with the friction parts immersed in either AMG-10 oil or TS kerosene. Measurements were made over a $1.92 \cdot 10^4$ m long friction path in 12 intervals. Statistical processing of the data by the method of approximation has yielded trinomials $y_w = a_0 + a_1x \pm a_2x^2$ describing the wear curve and binomials $y_\mu = b_0 \pm b_1x^{-1}$ describing the friction curve (friction coefficient $\mu = 2M_f/Qd_m$, M_f- friction torque, Q- load force, d_m= 31.5 mm - mean diameter of cylindrical rubbing surface) along the path coordinate x. An analysis of these results reveals that the wear resistance increases with higher alloying level, which is confirmed by a higher optimum carbon content and consequently a larger amount of excess phases in the surface film of the diffusion layer. Accordingly, $16Cr2N3MoVBN_2A1$-Sh

steel wears less than $12CrNi3N_2$ steel. The maximum precipitation of excess phase is attained by proper chemothermal treatment such as 2-stage nitrocementation in the case of $20Cr3MWVN_2$ steel. References 4: all Russian.

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DIE WITH DEVICE FOR GROUPING LAMINATIONS AFTER PUNCHING AND BEFORE STACKING INTO MAGNETIC CORES

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 6, Jun 86 pp 15-16

[Article by N. S. Muradov and L. S. Sokiryanskaya]

[Abstract] Assembly of magnetic cores for electrical machines involves either counting the laminations or gaging the stack height, both method being imprecise. Burrs after punching introduce an error into the nominal stack height, while thickness variances after punching causes deviations from the nominal stack height. The count method is used only for short stacks with few laminations, both methods requiring a special insert, loading and batching equipment. A solution to the problem is a mechnical counting device designed for inclusion in the die-and-punch rig and correct stacking without any additional equipment. The die, already consisting of an upper plate and a lower plate, a punch holder and a punch lifter, is furnished with this counting device which includes two marker plungers on spring mounts and an exchangeable pair of meshing sprocket wheels. This device facilitates grouping of laminations while they are being punched out, allows 180° rotation if necessary, and simultaneously counts them for correct stacking. It has been installed and is operating in a single-row progressive die-and-punch rig which produces and stacks laminations for the stator cores of PED-103 and BV5 submersible electric motors at the Kutaysskiy Electrical Machinery Manufacturing Plant. It replaces 10 workers and saves 40,000 rubles annually in production costs.

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AUTOMATION OF SHEET PUNCHING OPERATIONS WITH MLSh MANIPULATOR

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 6, Jun 86 pp 16-17

[Article by V. Kh. Mosiyan]

[Abstract] In order to meet the increasing demand for electrical machines and accordingly increase the production volume, it has been necessary to automate the lamination punching operations. For punching rotor laminations 250 mm in diameter and larger from circular blanks, specifically, there has been designed and built the MLSh automatic manipulator which operates with any general-purpose 1600-2500-3150-4000 kN press. It consists of a carrying hand with an electromagnetic gripping device, a permanent-magnet stripper, and a carriage. Its positioning accuracy is within ± 1 mm, the hand can travel up to 900 mm horizontally, the stripper can travel up to 650 mm vertically, and the carriage can travel 845 mm. It produces laminations at a rate of 12-14 pcs/min, with a working pressure of 0.45 MPa for the pneumatic drive. One such manipulator operates at the Vladimir Ilich Plant MPO and another operates at the Elektromashina Plant of the Azerelektromash Production Association, saving 5,000 rubles annually in production costs. Important features are the high reliability of the manipulator and simplicity of its controls.

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CONTROL ALGORITHM FOR DROP HAMMER OPERATION WITHIN FLEXIBLE PRODUCTION MODULE

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 6, Jun 86 pp 19-20

[Article by Yu. A. Bocharov, N. B. Babin, and Ye. A. Yudanov]

[Abstract] A control algorithm for a steam-air drop hammer operating within a flexible production module has been devised on the basis of a mathematical model describing the dynamics of the forging process, with available force and necessary impact energy for deformation work as the control criteria. The input parameters include the type of blank, its geometrical dimensions, initial volume as well as temperature, and properties of the material including its resistance to deformation and their temperature dependence. The boundary conditions correspond to the three stages of the hot die forging process, namely upsetting followed by impression filling and then trimming. The physical model of the hammer-blank-die system on a rigid base, eight masses with five elastic-viscous couplings on an elastic-viscous mount, has been reduced to an equivalent simple mass-spring-mass system on a spring mount. The control algorithm involves solving two equations, for the upper-steam pressure and the lower-steam pressure as functions of the ram displacement till the end of unloading, as well as calculation of the necessary energy of the next impact and the delay time for the valve reversal. The algorithm is designed for program control by computer. References 4: all Russian.

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UDC 621.97:621.73.06.002.237

MODERNIZATION OF HYDROMECHANICAL CONTROL SYSTEMS FOR FORGING PRESSES

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 6, Jun 86 pp 21-24

[Article by N. M. Zolotukhin, O. M. Shinkarenko, and V. Ye. Ustinov]

[Abstract] Several improvements in the hydromechanical lever-cam controls for heavy (32-63 MN) forging presses have been devised by the Kramatorsk Industrial Institute for the purpose of eventual automation. They have been implemented on foring presses manufactureed by the Heavy Presses Production Association and by the Uralmash Production Association and also installed on 32 MN forging presses now operating at the SKET combine in the GDR. The major improvement are 3-position and 4-position electrohydraulic servomechanisms, the zero-backlash variant offering compactness and high response speed. Special telescopic plungers eliminate intricate lever mechanisms for switching power stages, have a long life, can be easily dismounted and remounted in 10 minutes. The control panel, 530x420x95 mm^3, is moisture-proof with seven standard R102 distributors and a PG55 throttle mounted on it. Another improvement is 2-speed control of the press table. The cost of these improvements is relatively low. References 2: both Russian.

2415/12947
CSO: 1842/231

FEW CUSTOMERS FOR VACUUM TREATED STEEL

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 4 Jun 86 p 2

[Article by I. Mosin: "A Vacuum Around a Vacuum;" passage rendered in all capital letters printed in boldface in source]

[Text] THE NONCOORDINATION OF ACTIONS OF THE USSR MINISTRY OF FERROUS METALLURGY WITH USERS OF ITS PRODUCTION HAS LED TO MILLIONS OF TONS OF HIGH QUALITY METAL BEING OF NO USE TO ANYONE.

"You should not have attacked the metallurgists for the lag in the production of vacuum treated steel," declared one of the readers who phoned the editorial office. "There are no customers even for the vacuum treated metal which is being produced now."

I must confess that this telephone call, which came shortly after the publication of the article "Sideways to Progress" (SOTSIALISTICHESKAYA INDUSTRIYA 18 December 1985), at first puzzled me. Before this, I had talked with specialists of several ministries. And, all of them were unsparing in their reproaches of the USSR Ministry of Ferrous Metallurgy for the low quality of supplied metal.

"Each year we have to renovate hundreds of kilometers of track," said V. Kuznetsov, technical department chief of the MPS [USSR Ministry of Railroads] Main Administration of Lines. "Because of this operation the train schedules become complicated and the freight volumes are reduced. If the Ministry of Ferrous Metallurgy supplied us with longer lasting rails made of vacuum treated steel, this would produce a tremendous effect on our sector as well as on all the national economy."

In the current five-year plan, with the same volumes of metal consumption, we have to increase production output by thirty percent," declared V. Ivanov, deputy chief of the Main Technical Administration of the USSR Ministry of Chemical and Petroleum Machine Building. "For this reason, improvement of steel quality is a 'to be or not to be' question for us. After all, the equipment which the sector produces has to operate under conditions of high pressures, corrosive mediums, large temperature drops...."

"We have a list of products for approximately one and a half million tons that provokes justifiable criticism because of the low properties of the metal," said V. Bandulet, deputy chief of the Main Technical Administration of the USSR Ministry of the Automotive Industry. "We often raise the question of quality at the USSR Ministry of Ferrous Metallurgy. But, so far without any particular success."

There was still the USSR Gossnab that I could turn to so that I could completely dispel my doubts, started by the telephone call: Gossnab should be literally flooded with requests for vacuum treated metal judging by the statements of the employees at the ministries.

"Are you kidding?" retorted V. Genin, chief of the technical department of Soyuzglavmetall [Main Administration for the Supply and Marketing of Metal Products]. "Last year we received only one request for vacuum treated metal--from the bearing industry. And, we had to practically force it on almost thirty ministries..."

A folder was placed on the table that at a glance revealed that the demand was almost zero. The Gorkiy automobile builders sent a telegram to Gossnab stating: "The Gorkiy Automobile Plant has no need for metal that is vacuum treated outside the furnace." A refusal was also sent by the Pervouralsk Pipe Plant. The echo of similar messages appeared to have reached the metallurgical enterprises as well and this became a cause for alarm.

"The cost of the additional treatment of steel was 7.28 rubles per ton; the loss--about a million rubles," writes S. Ignatyev, director of the Donetsk Metallurgical Plant. ""I am asking you to let us know whether there is a need for rolled products made of vacuum treated steel. Otherwise, the plant will have to raise the question of putting the vacuumizer into storage until there is a need for it ..."

Similar documents had to cause anxiety. In recent months, the USSR Ministry of Ferrous Metallurgy has enacted a number of measures for increasing the output of vacuum treated steels. Enterprises that have vacuumizers have been given additional tasks, whose fulfillment is reflected in separate line entries. Such as, the imported vacuumizer, "stored" at the Orsk-Khalilovo Metal Combine, is to be moved to Chelyabinsk and put into operation in early 1987. Who is going to use all this high quality metal?

Attempts to get an answer to this question from the same employees of the user-ministries led to the "revelation" that they know the metal quality problem only "in principle": it would be good to get this metal! But, how and where can it be used with maximum efficiency --industrial science holds these "details" in its hands.

For example, in the USSR Ministry of Railroads the problem of improving the operational strength of rails was assigned for study to

the All-Union Scientific Research Institute of Railroad Transport. A. Velikanov, director of an institute department, told us willingly that rails made of vacuum treated steel were first tested in the sixties, but the tests did not produce favorable results. Individual experiments, which were not numerous, were also staged later. Finally, during the past five-year plan in accordance with the program of GKNT [State Committee for Science and Technology], scientific research was to be conducted with an output of experimental batches of rails made of vacuum treated steel. But...

"Unfortunately, all our attempts to force the Ministry of Ferrous Metallurgy to carry out the assignments of giving us rails for testing have produced no results," said A. Velikanov.

"Whom did you ask? And, what did they reply? You probably have kept copies of the documents?"

But, A. Velikanov indicated there were no such documents, only talks.

A conversation at the All-Union Scientific Research and Design Institute of Chemical Machinery Manufacture also produced a similar result. M. Shapiro, the sector chief, easily listed the areas of chemical machine building where vacuum treated metal can find application: compressors, high pressure apparatuses, and machinery for the North. However, when the conversation touched on what is being done in this direction, the sector chief with difficulty found a document--it was dated three years ago. No, this was not a letter from the machine builders to the metallurgists with a request for deliveries of high quality materials. Just the opposite, the UkSSR Ministry of Ferrous Metallurgy itself offered the scientists to conduct scientific research studies, related to the use of vacuum treated metal. What was their answer? M. Shapiro informed me that the question is still "in the negotiation stage".

The conclusion to be drawn was simple: while many users insist on high quality supplies, they are not ready for their application. Moreover, with rare exception, there is still no great interest in such metals. The inactive position of industrial science is merely a mirror, reflecting the mood of the staff at the ministries; the staff can and should demand from industrial science advanced research and developments that are directed at making use of these high quality materials. Why hasn't this happened?

The problem of sharply reducing metal consumption in the national income was raised in the Basic Directions accepted by the 27th Party Congress. The machine building complex, for example, has to increase production output by 40-45 percent, after reducing its "weight" by 12-18 percent. Seemingly, this problem cannot be solved without high quality materials. However, there still appear to be considerable potential reserves in the sectors, since Gossnab is not flooded with requests for vacuum treated metal.

I foresee the objections that, despite the sharply raised questions about quality, technical level, and metal consumption of production, many normative documents which stimulate work in this direction are still lacking. In many cases, the same quality indicators are put into the technical documentation for vacuum treated metal as for regular metal. However, this opinion does not remove responsibility from the developers of the new technology--their profession obligates them to find and apply more efficient materials. True, there is also another side to this problem.

"Don't rush to blame the users," Doctor of Technical Sciences V. Belosevich, chief of the Scientific Research Institute of Motor Vehicle and Tractor Materials, said in response to my conclusions. "For a designer the concept of "vacuum treated" metal is an abstraction. He has to know into what type profile--pipe or other rolled product type of this metal--it will be converted into, what the dimensions of this profile will be, and its strength and many other characteristics. But, most important a designer should be certain that when a vehicle is on the conveyer the rolled product will be available in the required amounts..."

"Well, one can get these data. If not at Gossnab, then from the metallurgists at the Ministry of Ferrous Metallurgy..." I said.

"Are you sure?" smiled the scientist. "I'm afraid that even now the Ministry of Ferrous Metallurgy is not quite clear on this question."

"Why?"

"Judge for yourself. In the current five-year plan our plants will start to produce several new brands of automobiles. However, they do not contain vacuum treated metal, if we do not count the metal of the automobile body. Is this an omission on the part of the designers? No, they started to plan these automobiles ten years ago. At that time, the Ministry of Ferrous Metallurgy was not thinking about expanding the vacuum treated steel program. And, if such intentions did exist, then the metallurgists should have started to prepare the designers for the new materials even earlier--five years ago or so..."

"But, the situation has to be corrected somehow. The Ministry of Ferrous Metallurgy is already planning to sharply increase vacuum treated metal production in this five-year plan."

"It will have to be corrected now, but at what cost? Making parts from this metal of the same shape and size is senseless: after all, it is more expensive. And, once you start to change parts dimensions then you have to reexamine almost the entire design. Not only the design, but the technology as well. The lesson that we have to learn is: for a new material to painlessly receive widespread application, the suppliers must start working together with the users as early as the idea of its development matures..."

It was difficult to object to anything. The only question was: how can the partners--the suppliers and users--be induced now to move ahead toward high quality? Many specialists believe there is a powerful lever for this--higher standards in which the growth of requirements is "scheduled" strictly according to year. For example, so far some standards with reference to metallurgists are excessively "soft". As an example, in accordance with the accepted decisions almost all the bearings in the past five-year plan should have been produced from vacuum treated metal. But, so far the standards that exist for metallurgists are two--old and new. And, the old standard understandably allows them to get along without vacuumization.

The employees of the State Committee of Standards of the USSR Council of Ministers may object: for standard requirements to be raised to a new height, one has to be sure that both the supplier and the users are able to meet the higher standards. Even if at maximum effort, they will be able. In other words, new heights cannot be "fixed" speculatively. Here, each step has to be checked scientifically--with the same joint research of the partners that must be carried out immediately. Who is responsible for organizing this?

One would think the USSR State Committee on Science and Technology. Its place is wherever shoots of bold scientific ideas are appearing, and whenever an interest in them has to be produced and support for them is needed in the most diverse sectors. None of these ideas should take us by surprise in the future, but should come to us according to a worked out schedule with the speed and precision of an express train. Then, we will be working in a new way.

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FIRST RESPONSE TO PRECEDING ARTICLE

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 8 Jun 86 p 1

[Letter to editor by Candidate of Technical Sciences O. Cheremenskiy of the Scientific Production Association of the All-Union Scientific Research, Design and Technological Institute of the Bearing Industry: "One Must Keep His Word"]

[Text] Improvement of metal quality with vacuumizing is a problem of great state importance. As far as I can recall, SOTSIALISTICHESKAYA INDUSTRIYA has considered this subject three times in its paper. As a specialist, vitally interested in receiving such metal for the needs of the bearing industry, I will say frankly: certain changes for the better have taken place, but the Ministry of Ferrous Metallurgy still moves much too slowly. For example, last year we received only one tenth of the vacuum treated metal that we needed. This year the metallurgists firmly promised us to increase deliveries

by almost three-fold, however, it is already clear that they will be unable to keep their word. Even the assignment, signed by the Minister of Ferrous Metallurgy, to the Orsk-Khalilovo Metal Combine for the production of vacuum treated steel is not being carried out. This metal is essential to us and, for this reason, we demand that the Ministry of Ferrous Metallurgy fulfill its obligations.

[Signed]

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PERFORMANCE OF PLASMATRON USING MIXTURE OF NATURAL GAS AND AIR

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 86 (manuscript received 6 Feb 85) pp 55-59

[Article by A. S. Anshakov and V. V. Stenin, Moscow]

[Abstract] The main problem in the operation of plasmatrons generating a hot reducing medium with natural gas as active substance is carbon deposition on the walls of the discharge chamber. Carbon is produced by pyrolysis of natural gas and, as its deposit builds up, degrades the plasmatron performance, eventually causing shutdown. One way to slow down this process and thus extend the life of such a plasmatron is diluting the natural gas with another gas such as air or nitrogen. Use of nitrogen is not economical and, therefore, mixing the natural gas with air far below the 25% excess level corresponding to methane conversion is considered. An experimental plasmatron with cathode--starter--spacer--anode in a linear configuration was tested, the interelectrode spacer consisting of nine segments. The natural gas was injected through swirling annular channels between spacer segments. The air was injected through the clearance between the last spacer segment and the anode as well as through the clearance between the first spacer segment and the starter segment. The intake of natural gas was varied over the $(1.4\text{-}4.2)\cdot10^{-2}$ nm^3/s range and the intake of air was varied over the $(1.4\text{-}8.3)\cdot10^{-3}$ nm^3/s range, the excess air thus being varied within the 4-10% range. The cathode was shielded with nitrogen flowing at a rate of $2.8\cdot10^{-3}$ nm^3/s. The probability of carbon deposition was lowered, but not completely eliminated, by injection of air past the last spacer segment. The length of flawless operation, namely the time from start of a discharge to beginning of carbon deposition on the anode, was found to depend on the surface condition of this electrode. Extensive use and especially frequent switching on and off cause development of surface roughness under the arc and shorten the life of the anode, the life of a fresh and smooth anode being relatively long. An improvement is an anode with a biconical exit channel segment following a cylindrical main channel segment. A plasmatron with such an anode retained a fairly flat current-voltage characteristic and an 85-88% high efficiency over most of the given range of input parameters. References 3: all Russian.

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UDC 621.783

DEADEND RADIATOR TUBES OF DOMESTIC PRODUCTION FOR 'EICHELIN' CHEMICAL AND HEAT TREATMENT APPARATUS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 86 pp 22-23

[Article by V. G. Goman, L. G. Shults, and E. P. Perevoshchikov, Kuybyshev Polytechnic Institute]

[Abstract] Chemical and heat treatment apparatus produced by Eichelin is operating in Soviet industry with deadend radiator tubes as heating elements. These are built according to a scheme where combustion takes place inside the inner tube and raises its temperature 100-150°C above that of the radiating outer container-tube, with lateral air and fuel (natural gas) injection from outside and with exhaust of flue gases through the central duct. The first Eichelin radiator tubes made of 25-20 Cr-Ni steel were found to blister and burn out. They have been replaced by Eichelin with ceramic tubes of segmental construction; however, their useful life is short because of leakage and breakage. Such radiator tubes now produced in the Soviet Union are made of 23-18 Cr-Ni steel with the recuperator sleeve around the flue duct made of cast 30Cr24Ni12Si steel. Replacement of Eichelin radiator tubes with these Soviet-made ones in five machine manufacturing plants which use altogether 11 sets of Eichelin equipment has reduced the consumption of natural gas to 0.7-1.0 m^3/h per set or by 6-10% overall. They are installed in vertical position, in arrays of 32 per set, and operate at an efficiency approaching 75% using natural gas with a heat of combustion within the 33-35.5 MJ/m^3 range so that the temperature of the flue gases does not exceed 530°C under the maximum load. These radiator tubes have an outside diameter of 152 mm and are 1000 mm long. References 1: Russian.

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EFFECT OF TITANIUM AND NITROGEN ADMIXTURES IN STRUCTURAL STEELS ON GROWTH OF AUSTENITE GRAIN DURING HEATING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 86 pp 27-31

[Article by Ya. N. Malinochka, T. M. Titova, and P. L. Litvinenko, Ferrous Metallurgy Institute, Dnepropetrovsk]

[Abstract] Addition of titanium and nitrogen to deoxidized medium-carbon steels has been found to result in formation of titanium carbonitrides with various ratios of carbon to nitrogen rather than pure carbide and nitride, owing to isomorphism and complete mutual solubility of the latter. The effect of high-temperature preheating of such steels on the growth of their austenite grain during subsequent heat treatment and thus on their mechanical properties was studied in an experiment with three grades of structural steel. Samples were taken from 8.4 t and 4.3 t industrial ingots of grade-35 (0.36% C, 0.008% N_2) grade-45 (0.37% C, 0.007% N_2), and high-carbon rail steel (0.68% C, 0.013% N_2) to which titanium and nitrogen had been added in the form of ferrotitanium (1.0-3.0 kg/t) and nitrided manganese (1.5-4.5 kg/t) during smelting, also aluminum for deoxidation. Cast and rolled specimens of each grade were treated in three different ways. The first series were preheated to 1300-1350-1400-1440°C and quenched after 20 min or 60 min before normalization at 870°C. The second series were similarly preheated and quenched before being tempered at 700°C. The third series were similarly preheated and quenched without being normalized or tempered afterward. The growth of the austenite grain was then monitored during subsequent heat treatment at standard temperatures from 900°C to 1100°C and beyond up to 1320°C. The results reveal that high-temperature preheating of these steels with titanium and nitrogen admixtures inhibits the growth of the austenite grain during subsequent heat treatment to no growth at all at temperatures up to 1100°C and to a very slow growth at temperatures above that. The higher the preheating temperature has been, the farther upward will extend the temperature range within which no grain growth occurs during subsequent heat treatment. Normalization and tempering were found not to influence that grain growth. References 13: 8 Russian, 1 Polish, 4 Western (2 in Russian translation).

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UDC 669.14.018.29

PROPERTIES OF 16Mn2N$_2$V STEEL AFTER NORMALIZATION AND REFINEMENT

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 86 pp 35-36

[Article by L. V. Popova, A. G. Nasibov, and N. I. Karchevskaya, Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin]

[Abstract] A comparative study of normalized and refined 16Mn2N$_2$V steel (0.17% C, 1.55% Mn, 0.09% V, 0.018% N$_2$, 0.55% Si, 0.03% A1, 0.013% P, 0.005% S) was made, for the purpose of determining the effect of each treatment on the mechanical characteristics. Ingots weighing 17 kg were produced in a 50 kg induction furnace and forged into billets 60 mm in diameter. These were hot rolled into 12 mm thick, 60 mm wide, 400 mm long strips in four passes with a terminal rolling temperature of 850°C. One batch of strips was normalized at 920°C for 20 min. Another batch of strips was refined by water quenching from 950°C after 20 min at that temperature and then tempering at 680°C for 1.5 h with subsequent water cooling. With smooth surfaces, both batches were tested in tension in the direction of rolling at room temperature and found to have almost identical strength (ultimate, yield) and plasticity (elongation, reduction). Impact tests revealed a much higher strength of refined steel, its cold-shortness threshold temperature being 50°C lower (-60°C) than that of normalized steel (-10°C) and its toughness remaining high (170-240 J/cm^2) down to -50°C. While normalized steel has a ferritic-pearlitic structure, refined steel has a bainitic-martensitic one. The results of phase and chemical analysis indicate also that after normalization all the bound nitrogen appears in vanadium carbonitride, while after refinement it is distributed almost equally between vanadium carbonitride and aluminum nitride. References 1: Russian.

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UDC 621.785.1

OPTIMIZATION OF THERMOMAGNETIC TREATMENT OF PERMANENT-MAGNET CASTINGS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 6, Jun 86 pp 37-39

[Article by G. I. Neduzhiy, V. I. Shutov, and Yu. S. Izgorev, Kiev Automation Institute imeni 25th CPSU Congress]

[Abstract] Thermomagnetic treatment of permanent-magnet castings and particularly the intricate important cooling process are analyzed theoretically for the purpose of optimization. The mechanism of high-coercive spinoidal breakup of a solid solution in a multielemental alloy is interpreted geometrically in temperature-time coordinates, on the basis of the 2-stage break-up model proposed by B. G. Livshits for Alnife alloys and experimental data obtained with a thermomagnetic analyzer. These experimental data include critical phase transformation temperatures of the YuNDK25BA alloy, the cooling curve for a specimen 60 mm long and 10 mm in diameter, and the emf-time curve where the emf of the measuring coil indirectly characterizes the change in free energy during transition into the ferromagnetic state. The thermomagnetic analyzer is the key element for optimizing the production of permanent magnets by automatic control of the cooling process. It includes a heater and a set of thermocouples, a magnetizing coil (12 V-250 kHz, 500 turns of copper wire 0.3 mm in diameter) and a measuring coil, a cooling rate regulator, two amplifiers, two analog-to-digital converters, a synchronizer, a memory register, a comparator, a time, a counter, a time indicator, an extremizer and an emf indicator, a temperature indicator and a computer. It can be particularly helpful in the production of special-purpose permanent magnets and multielemental alloys. References 2: both Russian.

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EFFECT OF PRIME LAYER ON MAGNETIC PROPERTIES OF HIGH-COERCIVITY SILICON STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 6, Jun 86 pp 39-42

[Article by R. B. Puzhevich, A. G. Dukhnov, Ye. A. Samsikov, V. G. Borisenko, and L. A. Shvartsman, Ural Scientific Research Institute of Ferrous Metallurgy, Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin, Novolipetsk Metallurgical Combine]

[Abstract] A study of high-coercivity grain-oriented silicon steel with an MgO coating was made, for the purpose of determining the effect of the $2MgO.SiO_2$ prime layer formed during high-temperature annealing on the magnetic properties of this steel. Specimens were annealed, some in an atmosphere of 95% N_2+ 5% H_2 with the ratio $\emptyset_{H_2}/\emptyset_{H_2}$ characterizing the oxidation potential equal to 0.02 throughout the cycle, or to 0.12 at 600°C, or to 0.12 at 850°C and some in an atmosphere of H_2 with the moisture content varying and that ratio correspondingly varying over the 0.042-0.006 range during the process. For comparison, the same treatment was applied to specimens with coating and to bare specimens. The tensile stress in the crystallographic [100] direction which the prime layer produces upon heating was estimated at 4 N/mm², on the basis of the dimensions and the known properties, namely modulus of elasticity and linear thermal expansion coefficient, of the steel specimen and the prime layer. The magnetic properties were measured by the ballistic method and with a wattmeter for the specific power loss at 50 Hz frequency and 1.7 T maximum magnetic induction. The results indicate that the prime layer on grain-oriented and thus anisotropic silicon steel can either increase or decrease the specific power loss, depending on the structure of the steel surface layer and on the degree of its grain orientation as well as on the stress pattern produced by the prime layer. The stress can be a simple uniaxial tensile one when the grain orientation is perfect or a complex multi-directional one when the steel surface layer is heterogeneous with some degree of grain disorientation. Uniaxial tensile stresses up to 10 N/mm² were found to reduce the magnetic power loss, especially so and by up to 10% when produced in steel without a prime layer and a heterogeneous surface layer. References 10: 3 Russian, 7 Western.

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DESIGN AND PERFORMANCE ANALYSIS OF ECONOMY FURNACES FOR NONOXIDIZING PREHEAT OF TURBINE BLADES

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 6, Jun 86 pp 35-36

[Article by V. I. Berbenev]

[Abstract] A furnace for nonoxidizing preheat of blank metal before precision punching of turbine blades has been developed at the All-Union Scientific Research and Planning Institute of Heat Engineering Structures (VNIPI Teploproyekt). The blank metal is heated in the main furnace chamber in an atmosphere of products of incomplete combustion, natural gas being burned with 500-600°C hot air from a slotted radiation-type recuperator entering the GNP-B burner at half the rate necessary for complete combustion. The remainder is afterburned in another chamber with spent air entering through nozzles, afterburner chamber and main chamber being separated by a roof consisting of carborundum plates. Both the fuel rate and the air rate to the GNP-B burner for incomplete combustion remain constant during the furnace operation. The excess air in the flat afterburner for complete combustion is first set at a level, within the 10-50% range, ensuring complete combustion and then also remains constant during the furnace operation. The temperature in the heating zone is regulated by adjustment of air and fuel flow to the afterburner, radiation of heat from the afterburner chamber into the main chamber through a window in the roof contributing to a faster and more uniform heating of the blank metal. Several versions of such a furnace, among them a ring furnace using six GNP-B-2 burners and two GPP-N-3 afterburners with one recuperator, have been designed for nonoxidizing preheat of carbon steels and high-alloy steels at the Leningrad Turbine Blade Manufacturing Plant.

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HEAT TREATMENT OF WELDED JOINTS OF 36NiCrTiA1 ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 6, Jun 86 pp 42-44

[Article by B. Akhmetzhanov, V. F. Sukhovarov, R. D. Strokatov, and V. T. Marytnenko: Ust-Kamenogorsk Pedagogical Institute; Institute of Strength Physics and Materials Science, Siberian Department, USSR Academy of Sciences, Tomsk; Manometr Interindustrial Association (MPO)]

[Abstract] An experimental simulation study of welded joints of the standard dispersion-hardened 36NiCrTiA1 alloy (0.03% C, 44.4-49% Fe, 34.5-36.0% Ni, 11.5-13.5% Cr, 2.8-3.2% Ti, 0.9-1.2% A1, 0.8-1.2% Mn, 0.5% Si) for sensing elements in control devices was made, for the purpose of determining the cause of their deficiency and improving the heat treatment so as to eliminate it. Specimens, 0.3 mm thick ribbons 5 mm wide and 85 mm long, were quenched from 1050°C in water after 7 min and then electrically polished. Welding seams produced by an ASTE-7 argon-arc machine (25 A, 0.011 m/s) or by an A 306.13 electron-beam machine (13 mA, 0.014 m/s) were simulated by melting a 1.5 mm wide strip across in the middle and then grinding it down to original dimensions within the seam region. One batch of such specimens was aged at 700°C and another batch was first quenched again, this time from 970°C, before aging at 700°C. Microhardness measurements and structural examination of the seam and the thermal influence zone indicate that crystallization of the melt during cooling occurs with formation of a disperse dendritic-cellular structure in the seam and of a transitional interlayer between melt and solid metal. Subsequent aging results in discontinuous precipitation of the $\gamma^1(Ni_3A1)$-phase in the seam. Quenching before aging causes discontinuous breakup not only in the seam but also in the thermal influence zone during subsequent aging so that structure in the thermal influence zone becomes the same as before welding. Accordingly, the second quenching has restored homogeneity of the material outside the welding seam and this results in better and more durable joint. The second quenching also increases the strength of the material in the thermal influence zone and its resistance to propagation of cracks usually initiated in the weaker transitional interlayer. References 2: both Russian.

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MONOGRAPH ON GEOLOGY OF COBALT ORES

Baku VYSHKA in Russian 18 Mar 86 p 2

[Article by G. Tvalchrelidze, director of the Geology Institute imeni Dzhanelidze of the Georgian SSR Academy of Sciences, honored scientist of the republic, and academician of the Georgian SSR Academy of Sciences: "In Search of Cobalt"]

[Text] Cobalt is regarded as one of the most important metals since its various alloys are widely used in the aviation, chemical, metallurgical, electrical engineering, and many other sectors of industry. Demand for it is quite high in developed countries. The principal suppliers of cobalt ore are African countries, primarily Zaire and Zambia, on whose territory are located numerous copper and cobalt deposits.

The Soviet Union began working the Dashkesan cobalt deposit in Azerbaijan SSR in 1937. It was the first of the corresponding sector of domestic non-ferrous metallurgy. The results of a comprehensive study of this deposit were widely used in searching for similar ones in other areas of the country, mainly in Siberia. Now, in connection with the depletion of the Dashkesan deposit, there is an urgent need to meet the national economy's growing demand for cobalt ore.

In this connection, the monograph of A.I. Makhmudov, "Mineralogiya kobaltovykh rud" [Mineralogy of Cobalt Ore] (Moscow, Izdatelstvo "Nedra", 1982), warrants paramount attention. It has evoked a great amount of interest among Soviet and foreign geologists studying the geology and mineral composition of cobalt deposits. Many years of the author's research on a high scientific level comprise the basis of this monograph.

In addition to the Dashkesan deposit, he carefully studied numerous other deposits and manifestations of the Dashkesan, Ordubad, Kelbadzhar, Belokany, and other ore regions of Azerbaijan. The detailed studies were accompanied by the use of mineralogical and geochemical analysis methods--microprobe, chemical, spectrum, thermal, X-ray thermal, and many others. In so doing, A. Makhmudor discovered 80 minerals new for the areas studied, some of which were not known to be in the USSR before (alloclasite, modderite, carolite, and others). Determining the form in which cobalt is found in chromium, tungsten, copper, and mercury ores is of great importance. In particular, determining the form in which cobalt is found in chromium, tungsten, copper, and mercury ores is of practical interest. Identifying cobalt-bearing pyrite ores in Ordubadskiy Rayon of Azerbaijan is of particular practical interest. They warrant further study as a possible new source of cobalt.

The monograph is a complete summary of modern data on the mineralogy of cobalt ores and can serve as a reliable reference aid in geological works for studying deposits of cobalt and cobalt-bearing ores of a wide variety of regions. The author develops the prospects for cobalt from certain chromite, tungsten, pyrite-complex, and cinnabar-antimonite ores. These ideas may have applied importance in working deposits such as those in the Caucasus as well as in other parts of the country.

A. Makhmudor has developed an original genetic classification of cobalt and cobalt-bearing ores of deposits in Azerbaijan. Patterns of their association with magmatism have been established. In addition, he has substantiated forecast evaluations for cobalt of the most promising territories within various regions of Azerbaijan, which can serve as the basis for setting up geological works there aimed at discovering new actual deposits of cobalt-bearing ores. In this case, the use of A. Makhmudov's summary on mineral carriers and concentrates of cobalt and its associated elements will be valuable. Therefore, this monograph should become the base in developing the technical and economic considerations necessary for geological exploration projects of new mineral deposits. In connection with all the above, the monograph can be considered a major contribution to the problem of studying ore deposits of the Caucasus, the patterns of their formation, and the details of their composition. There is no doubt as to its great scientific and applied importance. The principal theses defended in the monograph may also be successfully used in studying deposits in other ore provinces of the Soviet Union. Therefore, I am deeply convinced that the monograph of Professor A. Makhmudov, doctor of geological and mineralogical sciences, fully merits being awarded the Azerbaijan SSR State Prize.

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DEVELOPMENT OF SHALKIYA MINE IN KZYL ORDA OBLAST

Alma-Ata KAZAKHSTANSKAYA PRAVDA in Russian 8 Apr 86 p 1

[Article by Yu. Livinskiy, KAZAKHSTANSKAYA PRAVDA correspondent, Chimkent-Kentau-Shalkiya: "Shalkiya Begins Its Biography"]

[Text] Basic Directions for the Economic and Social Development of the USSR for 1986-1990 and for the Period Until the Year 2000 envisages the development of the new Shalkiya deposit located in the northwestern outskirts of Karatau. This big natural storeroom will greatly replenish the raw material base of the Achisay Polymetallic Combine. At the end of last year an experimental extraction block was put into operation at the underground Shalkiya mine under construction there. The first ore echelons arrived at the combine from the new deposit on the eve of the opening of the 27th CPSU Congress.

Shalkiya is located 160 km away from Kentau on the territory of neighboring Kzyl-Orda Oblast. We drove there together with P. P. Sidorenko, chief geologist of the Achpolimetall Combine. En route he told us that, as a result of the long-term exploitation of the combine's old mines concentrated in Central Karatau, some had already depleted their basic reserves and others have been greatly exhausted. The commissioning of the new prospective deposit will make it possible not only to replenish the mineral and raw material resources of the ore dressing enterprise, but also to increase the volume of ore output considerably.

"The planned capacity of the Shalkiya mine will be the largest of all those existing in the republic," Pavel Petrovich stresses. "During the 11th Five-Year Plan the state plan envisaged putting its first stage into operation. However, owing to the fact that the Kazakh SSR Ministry of Nonferrous Metallurgy allocated insufficient funds, these periods, obviously, were prolonged. Therefore, the following decision was adopted: Not to wait for the full completion of construction of the first stage, but to commission new capacities in blocks."

"What will this give you?"

"First of all, this will enable us to gain time. The commissioning of new capacities, as blocks are ready, will accelerate the additional intake of ore at the combine and shorten the periods of mastering the technology of its extraction in stopes and processing at the concentrating factory."

An outline of tall structures scattered over the steppe appeared in the foreground.

"This is the Shalkiya mine," Sidorenko said.

Subdivisions of Mirgalimsaysvinetsstroy, Zolotoshakhtoprokhodka, Kzylordastroy, and Sredaztransstroy trusts are building the new mine. In fact, construction and installation work is only beginning here, although more than 50 million rubles of capital investments have already been utilized. At the mine two main shafts have been sunk, a lift hoist has been put into operation, the second extraction block is being prepared underground after the first one, and a 2-km motor transport ramp, on which mining machines, large-size equipment, and materials are delivered to stopes, has been built from the surface to both mining levels. On the industrial site the installation of a number of tall buildings has been completed and the foundations for an output headframe, hoppers for ore, and other facilities are being laid. A railroad branch line with a weighing room, a warehouse on the line, and a platform has been laid from Yanykurgan to the deposit.

The biggest volume of construction and installation work was carried out by the Shalkiya Mine Construction Administration of the Zolotoshakhtoprokhodka Trust. Incidentally, the collective of this administration developed there on the base of the sinking section. It made mine workings during geological surveying and after the confirmation of the deposit's reserves and engineering plan was the first to begin the construction of the underground mine in 1980.

Shalkiya's sinkers are constant leaders in the socialist competition among the mine builders of the republic's Ministry of Nonferrous Metallurgy. From the very beginning of construction of the underground mine they have been performing capital-construction work ahead of schedule. For example, during the years of the past five-year plan they utilized about 18 million rubles, which was much more than planned. As a result, the first start-up complex--the experimental extraction block--was delivered to operators 2 months earlier than the set date.

From the day of organization of the mine construction administration it has been headed by S. M. Myrzaraimov, one of the trust's veterans.

"We are proud that the prospective Shalkiya deposit has been reflected in Basic Directions for the Country's Economic and Social Development for the 12th Five-Year Plan," Said Merkarimovich says. "At the same time, we understand that this imposes on us, the builders, special responsibility."

Competition for the rates and quality of work and for a successful implementation of the decisions of the 27th CPSU Congress has widely expanded among mine builders. As before, V. Chulkov's brigades of sinkers and Kh.

Ermetov's brigades of concrete workers are in the lead. These advanced collectives working on a contractual basis completed the assignment of the 11th Five-Year Plan much ahead of schedule. Exceeding shift assignments every day, they have started the new five-year plan confidently. The administration's other brigades are also working on the construction of this mine in a shock manner. Recognized leading lights--sinkers A. Panarin, V. Zhiganov, A. Kalkhodzhayev, and V. Gerus, concrete workers A. Makhkambayev and S. Abduzhapparov, and fitters P. Dekanskiy, Kh. Aslanidi, and V. Sivak--set the tone in work.

In Shalkiya we also met A. Ye. Begimbekov, the mine's chief. He worked at the Achpolimetall Combine more than 30 years and was the chief engineer at the Mirgalimsay mine for a long time. Since the beginning of last year he has headed the newly built ore mining enterprise.

"Our collective is still small," Abdukhan Yermakhanovich said. "Kentau's miners, who work here by the watch method, form its basis. They are making development workings at some sections of the experimental block so that it may be possible to begin stoping this year. In addition to them we are training young people and are preparing a new reinforcement of mine workers from local residents for us. Thus, the collective is growing gradually and, as the saying goes, the future belongs to it."

Now the main concern of the miners of the youngest mine in the republic is how to prepare the stoping front at the experimental block as quickly as possible. Leaders in the socialist competition in sinking have already been determined. They are labor veterans and youth mentors T. Raykhanov and M. Tursunbekov and young workers A. Ashirov, R. Mulyunov, and others.

With the beginning of stoping the experimental block will become a distinctive proving ground for the development of an efficient technology of ore extraction. The most advanced systems of mine workings with the utilization of self-propelled equipment, which are used successfully at the combine, will be tested here. According to the results of these tests, with due regard for local geological conditions, the best of them subsequently will be widely and firmly established at the mine, which will make it possible to ensure a high productivity in stopes.

On the day of our arrival at the mine the scheduled train with ore departed from there to the Achisay Polymetallic Combine. For now this is only by-product ore extracted during the sinking of a motor transport shaft and the performance of mine development work at the experimental block. However, genuine ore will arrive from stopes soon. In time its flow will increase immeasurably. Shalkiya has a great future.

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SYNTHETIC YTTRIUM-ALUMINUM GARNETS FOR LASERS

Moscow MOSKOVSKAYA PRAVDA in Russian 14 Apr 86 p 3

[Article by Candidate of Geological and Mineralogical Sciences T. Zdorik: "What Color is Garnet?"]

[Text] No, we are not talking about the fruit of the pomegranate tree which is bright red under the dry brownish skin, but the precious stone, the mineral garnet. You will say, is it red? Such an answer would not be wrong. You see, it is usually believed that the garnet was given its name precisely because it resembles the seedy reddish fruit. Perhaps the most famous is the fiery-red garnet--the pyrope.

The beautiful pyropes of old are mined and cut on Czech soil. There is even a special garnet museum in their native city of Trebnice. In particular, it has a unique pyrope weighing 458.5 carats (1 carat = 0.02 grams) and the size of a pigeon egg. Garnet jewelry given by the great German poet J.W. Goethe to the young Ulrike von Levetzow occupies an honored place in the museum. It includes a necklace, bracelets, a brooch, earrings, and a ring.

Pyropes are found in volcanic pipes, often in the same ones as diamonds. In such cases the pyropes, as true complementary rocks of diamonds, offer considerable help in searching for them. They accompany diamonds both in Africa and Brazil, as well as in Yakutia in our country. Unlike the Bohemian pyropes or "cape rubies" of South Africa, domestic garnets extracted at the same time as diamonds are practically not used by our jewelry industry. That is a pity. After all, the precious and beautiful garnet stone adorned jewelry in Ancient Russia from time immemorial. Between the 16th and 19th centuries they called it andradite and distinguished between Bohemian andradite, that is pyrope, and eastern andradite or almandine, also a red garnet which came to Russia from Alabanda in Asia Minor.

Almandine is the most prevalent precious garnet in nature. It is formed in granites, but is usually extracted from placer deposits. Often it is not faceted, but only "smoothed out" by tumbling in special rotating drums. Beads from such garnets are exported today by India and other countries of the East. The best almandines are wine-red in color, but the stone often has a violet tint.

So, red garnets are actually the most prevalent and best known in jewelry. Let us recall, however, how A.I. Kuprin described the stones in his well-known story "The Garnet Bracelet." In addition to the stones "lit up with a lovely, deep red fire," there was another--a green one.

Today we know there are a full three natural green garnets. The bright green uvarovite usually forms cavities of fine garnets. Like a sparkling cloak it lines small pockets and fissures in ores of chromite deposits. You see, it is precisely the element chromium which gives it the green color. The yellow-green grossularite, resembling the color of gooseberries and even called by the Latin word for "gooseberry," is famous for its beautifully formed multifaceted crystals. These faceted beads do not require any artificial processing, for their colors are usually faded and subdued. The rarest and most spectacular golden apple-green demantoid garnet (with a brilliance reminiscent of a diamond) is valued in the jeweler's art above all other garnets.

But in addition to the red and green garnets, there are also the rose-colored rhodolite, the orange-yellow topazolite, the andradite of various shades of brown, and the black melanite, sometimes used in intricate funeral ornamentation. One even encounters quite colorless garnets. Only light blue garnets are missing in nature, just as there are no light blue roses! But since time immemorial man has sought to surpass nature. Sky-blue and cornflower blue garnets are grown in the depths of autoclaves of the All-Union Scientific Research Institute of Mineral Raw Materials Synthesis.

Their crystal structure corresponds to such natural analogues, but their composition is changed substantially. Aluminum takes the place of silicon, predominant in natural garnets; primarily yttrium and rare-earth elements take the place of chromophore ions--iron, manganese, and chromium. They also are capable of giving the substances the most varied colors, and the color range of yttrium-aluminum garnets (abbreviated YAG or "granatites," as they are not too successfully called in trade practice) is unusually wide.

It encompasses both red (incidentally, these are the rarest among YAG's) and rose colors, as well as orange-gold, lilac, and blue colors, and various shades of green. If one adds that there are synthetic garnets with an alexandrite effect, changing color from purple to green depending on the lighting, and calls attention to their bright "play" and high hardness, without exaggeration granatites or YAG's can be called one of the most beautiful creations of man's hands.

But, needless to say, garnets and other crystal substances are synthesized not only and not so much for jewelry. A wide range of artificial rare-earth garnets are produced throughout the world for the needs of modern equipment. Primarily they are used in various lasers, optical information transmission systems, color television, radar, computers, and so forth.

The most important field for using YAG's is optical electronics, lasers. As we know, lasers have been operating for a long time on synthetic ruby cores. Now YAG's are replacing them. The addition of various rare-earth and other elements make it possible to create lasers operating in a wide wavelength band in the most diverse sectors of the national economy.

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CHANGE IN ECONOMIC EVALUATION OF MINERAL DEPOSITS URGED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 30 Apr 86 p 2

[Article by V. Volkov, USSR deputy minister of geology: "Treasures at the Crossroads"]

[Text] Basic Directions for the Country's Economic and Social Development stressed the need to embark on a large-scale economic development of the zone of the Baykal-Amur Mainline [BAM]. Setting such a task is understandable: Many diverse natural resources were discovered in the BAM zone. Reserves of phosphorites and apatites--raw materials for the production of mineral fertilizers, without which it will be difficult to solve the problem of providing the rapidly growing northern and eastern regions with their own agricultural products--are of especially great importance.

Phosphorous fertilizers are now delivered here from the country's European part and Kazakhstan. There is a great need for them, but it is met very poorly. The utilization of local resources is the only possibility of eliminating this shortage.

In the qualitative composition of raw materials--the content of phosphorous anhydride in ore--new deposits, unfortunately, are inferior to the world famous Khibiny--the main supplier of apatites. Of course, this circumstance, as well as the fact that big reserves of phosphorous raw materials were discovered in remote, poorly inhabited regions, cannot be ignored. The question arises: Is it worth drawing them into the economic turnover?

Strange as it may seem, an unequivocal answer to this question does not exist today. The existing provisional standard method of a geological-economic evaluation of deposits gives only the most general, fundamental recommendations. In specific cases, however, it refers to sectorial methods, which have not been developed for most types of minerals, including phosphate raw materials, to this day. Thus, in fact, everything is decided by wholesale prices of the products obtained from the extracted raw materials. If they cover the expenditures on ore extraction and processing, production falls into the profitable category. If not, it is dismissed.

It seems that everything is logical and correct here. However, there is one fine point. Existing wholesale prices in no way take into consideration cost-

raising factors inevitable in new development regions. As a result, the construction of future enterprises often is questioned even in cases when there simply is no alternative variant.

The Seligdar apatite ore deposit in Yakutia is a graphic example. The large reserves of raw materials are characterized by a comparatively low content of the useful component and by quite a complex technological processing scheme. At the same time, Seligdar, like the Oshurkovskoye deposit in Buryatia, are the only projects on the territory of Siberia and the Far East from which it will be possible to actually obtain raw materials for phosphorous fertilizers during the next decade. The construction of an apatite plant operating on Seligdar raw materials is envisaged by Basic Directions.

However, with existing wholesale prices of mineral fertilizers, the development of Seligdar will be unprofitable. This served as the basis for the decision to include the reserves of this deposit in the category of reserves outside the balance. The State Commission on Mineral Reserves (GKZ SSSR) excluded them from those suitable for industrial utilization.

To us, the geologists, such a decision seems inadmissible. Some steps have been taken to place Seligdar's apatites at the people's service. However, negotiations with the USSR State Committee on Prices and the USSR State Commission on Mineral Reserves have not yet led to positive results. Departments, leaning on the letter of instruction, firmly stand their ground.

Many other deposits in regions gravitating toward the BAM zone are in approximately the same "suspended" state. Large explored reserves of iron and copper ore, aluminum raw materials, polymetals, and potassium salts are involved. The development of these deposits and the establishment of the production and social infrastructure for pioneer enterprises will require big expenditures. At the same time, the periods of recovery of capital investments, of course, exceed the limits set by standards. Hence, as a rule, the following conclusion follows: development is inadvisable.

It seems that the time has come to change the approach to the economic substantiation of the development of mineral deposits in remote eastern and northern regions. The national economic effect should be primarily the guideline here. If, for example, the same Seligdar is evaluated not on the basis of existing wholesale prices of mineral fertilizers, but the substantial guaranteed increase in the harvest of grain crops resulting from the application of presently scarce phosphates is taken into account, one will have to look at it in a completely different way.

Nor should high initial investments in the industrial development of the territory frighten us. After all, later on it will be possible to utilize the infrastructure created for the first enterprise both during the expansion of production and for the development of other types of mineral raw materials and forest and water resources. Today's expenditures will pay for themselves many times over tomorrow.

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PLANT CONSTRUCTION IS NEGLECTED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 27 May 86 p 2

[Article by V. Savenkov, chief of the construction sector of the Alma Ata City People's Control Committee: "An Orphan Right Next to the Ministry"]

[Text] A large machine building enterprise is being built on the outskirts of Alma Ata: a mining equipment plant of the Kazakh SSR Ministry of Nonferrous Metallurgy. We are concerned with the second section of the enterprise. The scheduled operational date for this section has already been postponed four times!

What does this dragging out of completion dates lead to? The miners will not receive the critical machines in time. And the equipment and the production lines are becoming outdated.

In January of this year, the management of the Main Administration of Alma Ata Construction and the Kazakh SSR Ministry of Nonferrous Metallurgy again passed a resolution to make the projects of the complex under construction operational in the second quarter. But, spring is almost over and the construction project is still ailing. The situation is such that putting the basic shops and auxiliary services into operation this time is again threatened by failure.

The entire project looks abandoned. In February, there were 70 construction workers instead of 120. And, in April there were even fewer workers--half of the fixed number. Sh. Mustafin, chief of a section of the Sredazenergokhimzashchita administration reported with disgust as early as March at an operations conference that his workers sat around for 15 working days at the project and were unable to do anything because there was no heat or electricity.

The management of the Main Administration of Alma Ata Construction appears to be quite undisturbed by the present situation at the project under construction. Last October Yu. Krasikov, chief of the Main Administration, visited the construction job. He conducted a conference based on the timeworn scheme of: planning, reinforcing and adjusting. But, nothing came of this, none of the managers of

the Main Administration of Alma Ata Construction ever appeared again at the project under construction. Following this example, A. Yermegiyayev, adminstrator of the contractor Alma Ata Oblast Heavy Construction Trust, has also forgotten his way to the building site.

K. Suleymonov, deputy director of the mining equipment plant for capital construction, complained: "With such an irresponsible attitude toward its work the Alma Ata Oblast Heavy Construction Trust, naturally, will not meet the scheduled dates for putting the capacities into operation..."

Chief Engineer of the PMK-29 [Mobile Mechanized Column] V. Shlak, a representative of the general contractor, objected: "The customer is deliberately finding negative examples and is misleading us as to the actual state of affairs at the construction job. The customer has not solved all the problems related to putting the capacities into operation."

Other arguments were also presented: the management of the plant, headed by B. Makhmutov, did not order the equipment or materials for these projects in the first place.

The matter of the second section was lost midst such mutual accusations. And, what about the management of the Kazakh SSR Ministry of Nonferrous Metallurgy? The project is located practically next door to the Ministry; however,none of the administrators has found the time to look into the matter and straighten out the situation at the construction job.

The visit of Minister S. Takezhanov to the construction job was awaited twice last year. But, he never came. It is true that Deputy Minister V. Ryadinskiy, engaged in capital construction problems, was present at the operations conferences several times. But, this is all. His presence was not reflected in the construction job work. As for the representatives of the Capital Construction Administration [CCA] of the Kazakh SSR Ministry of Nonferrous Metallurgy, headed by CCA Chief V. Pigulin and his Deputy Ye. Dyshelman, everyone at the construction job forgot what they looked like. After all, it is namely the CAA of the Ministry that has to figure out in detail the problems of complete equipment deliveries, has to report to management about the actual state of affairs at the project under construction, and has to introduce proposals for taking specific measures.

The local People's Control bodies have repeatedly tried to change the orphan fate of the plant under construction. The patrol members have reported to the Ministry management about the results of a check, which was conducted last year by the construction sector of the city People's Control Committee. The author of this article has also met with responsible comrades from the sector staff. They promised to look into the matter, but nothing has been done. Understandably, we were unable to resign ourselves to such a situation. On

the basis of our initiative, the question of accelerating the construction of the second section of the mining equipment plant was examined at the Alma Ata Oblast People's Control Committee and party gorkom. Customer and builder representatives promised to accelerate the job. But, even after this, the patrol members did not find any effective changes.

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BRIEFS

RECONSTRUCTION PLANS FOR ARMENIAN MINE--Specialists of the Armenian Scientific Research and Planning Institute of Nonferrous Metallurgy have put together the technical and economic estimates for the reconstruction of the Alaverdi Mine imeni Lenin. Its restoration will allow for considerable expansion and strengthening of the raw material base of the Alaverdi Mining Metallurgical Combine. It is important to note that the new deposits, which are rich in copper, were found by underground prospectors at deep levels next to an operating enterprise. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 14 Jun 86 p 2] 12525/12947

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REGENERATION OF REVOLVING SOLUTION DURING THERMOCHEMICAL ENRICHMENT OF BAUXITE

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 1, Jan-Feb 86 (manuscript received 7 Feb 85) pp 125-127

[Article by O. A. Dubovikov, A. N. Naumchik, and G. I. Shvachko, Chair of Metallurgy of Light and Rare Metals, Leningrad Mining Institute]

[Abstract] Thermochemical enrichment of bauxite is proposed, by a method which includes regeneration of the alkaline solution. This solution must be desilicized, considering that enrichment of bauxite is accompanied by formation of sodium hydroaluminosilicate at a rate which depends on both Al_2O_3 and SiO_2 concentrations. Tests were performed with Turgay bauxite (43.75% Al_2O_3, 12.80% SiO_2, 17.16% Fe_2O_3, 2.86% TiO_2, 0.72% CaO, 0.10% Na_2O, 23.12 wt.% loss on calcination). Irreversible loss of Al_2O_3 was prevented by splitting the regeneration process into two stages, namely first precipitating the sodium hydroaluminosilicate convertible into alumina and then converting the silica into calcium metasilicate. Fractional addition of lime during the interaction process requires a smaller total dose than one-shot addition and facilitates more thorough desilicization. References 3: 2 Russian, 1 Western.

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MISCELLANEOUS

COMMISSION VISITS DISRUPT PLANT OPERATIONS

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[Article by G. Dorofeyev: "One More Inspection...; More Than Thirty Commissions Have Visited the Donetsk Metallurgical Plant in the Last Two Months. Did They Help or Did They Interfere With Reorganization?"]

[Text] Before going to the Donetsk Metallurgical Plant, I decided to arrange a time for the meeting. I called A. Ryzhenkov, the partkom secretary.

"You better not come today," says Aleksandr Nikolayevich. "We have a commission working here and I will be busy."

Not to lose time, I call B. Krikunov, chief of the engineering department.

"We want to see you," says Boris Petrovich, "but, today and tomorrow we are busy preparing information for the commission."

This is becoming rather amusing. I call the production department.

"No," they answer, "our meeting has been cancelled. We will be busy for the next three or four days with the commission."

I feel something is wrong. I start to suspect that they simply do not want to see me.

"Of course, that is not so," objects Plant Director V. Slednev, "we are not hiding anything from you. Actually, all the specialists are busy preparing information for the commission..."

"Really, all of them?" I incredulously ask the director.

"You think this is strange? I think so, too. However, there are many commissions working at the plant. One commission checks safety engineering, another commission checks nickel consumption, a third one checks the production of economical types of rolled stock, the fourth ..."

Vladimir Petrovich lost count and gave it up as a bad job. He was appointed plant director in January of this year. By this time, the results of last year's work at the enterprise had already been summarized. The results, to put it mildly, were not pleasing. The plan had not been fulfilled for all the process stages. The collective owed tens of thousands of tons of cast iron, steel and rolled stock to its customers. There were still 115,000 unfilled orders. Intraplant losses of metal during its production exceeded 23,000 tons. There were many rejects.

It was not so long ago that the Donetsk metallurgists made the best steel in the world. The new director eagerly started to revive the traditions of the plant. As early as the first quarter, the situation started to change for the better. It is true that in January and February the metallurgists still worked with interruptions. But, those were echos of the slump. In March, the plan was fulfilled according to all indicators. The plant received almost four million rubles of above-plan profits. The intraplant losses of metal through rejects were reduced five-fold.

What happened during these months?

"The collective has remained the same," replied the director. "So far, we have not changed the equipment. What did change was the people's attitude toward the job, and labor and production discipline improved."

I was told about the earlier constant conflicts between the martensite shop chief and the maintenance personnel. While they were clearing up their differences, the accident rate rose, the number of unordered melts increased and, consequently, there were losses because of rejects. Instead of straightening out the situation, the former managers of the plant established personnel "leapfrog" here: in two years, five shop chiefs and three process engineers were replaced. Technological deviations became more frequent. The situation also became aggravated by the fact that unordered melts were put into production. The rationale was: perhaps, somebody will also need this type of metal. But, this did not work out. The rolled stock had to be written off. All this increased the losses.

V. Slednev had to work hard to establish in each case the specific guilty parties. Swaging Shop Deputy Chief B. Staratiyevskiy, Senior Foreman V. Yemchenko, and Shop Section Rolling Shop Chief V. But were seriously punished and warned.

The commissions appeared at the plant at the height of this analytic work. The most urgent jobs had to be put aside and information had to be prepared for the commissions. Every day experienced production organizers, whose job calls for ensuring the first breakthrough, are engaged in producing more paperwork. Can they do their real job? No, because they are expected to produce an increasing amount of new paperwork.

The reader should not think that we are against commissions and inspections. But, everything should be done in moderation! In March and April, there were five commissions, just from the union and republic ministries of ferrous metallurgy, working at the plant. One commission was checking the "correctness and observance of deadlines for communicating labor plans to the shops," another commission was checking "economic incentives for use of secondary resources", the third was checking "the filling of orders", the fourth was checking "assimilation of new technology" and so on.

Aren't there too many commissions for one enterprise? This is the question I asked the republic's Minister of Ferrous Metallurgy D. Galkin.

"The commissions do not only inspect," explained Dmitriy Prokhovich, "but help the enterprise to improve its work."

Seemingly, in theory this should be so. However, in practice everything is quite different. Last year and the year before, the plant collective failed dozens of times to fill the orders for melts. There was no shortage of persons inspecting, but the situation did not change. Improvements for the better took place only after management had been replaced. However, before the new director barely settled into his chair, he already had thirty (!) commissions bothering him in two months--fifteen in March and fifteen in April.

"This is improper," said the minister, "a director should not allow more than five commissions a month into the plant."

Of course, to have five commissions is better than fifteen or thirty. But, how can a director decide which commission should be allowed into the plant and which should not? Just try not allowing some inspector to come in! All commissions consider themselves to be the most important, although not one of them is responsible for anything. There would be markedly fewer commissions if the inspectors did not report by placing marks on paper, but by actual performance. Let's say a situation has improved at an enterprise after the visit of a commission, then this means the given problem has been solved; if a situation has not improved, let the commission assume responsibility for the failure along with the enterprise managers...

In April, there were four commissions from the Donetsk Center of Standardization and Metrology working at the plant. All of them were inspecting production output quality.

"We do not disturb the enterprise managers with our checking," said Acting Director of the Center B. Oleynikov, "but, work with the appropriate departments."

However, does this make it easier for anyone? While employees of the Department of Technical Control were preparing information for the

Gosstandart commission and Chief of the Technical Department B. Krikunov was explaining to the inspectors of the UkSSR Ministry of Ferrous Metallurgy how new technology was used, steelmaker Moskalenko in the electric steelmaking shop was allowing rejects. Almost twelve tons of metal were lost. It is not difficult to see the direct relationship between this loss and the increased paperwork of the plant specialists, who through no fault of their own have weakened their control over production.

"At the 27th Party Congress," Director V. Slednev told me, "it was distinctly and clearly said that less paperwork and more lively, creative work are needed. As you can see, we still do not have any changes..."

"One has to work better," countered Boris Petrovich Oleynikov, representative of Gosstandart in Donetsk, "then there will be fewer commissions."

The director smiled sadly: we have somewhat improved the indicators, but the commissions still remain. Great is the power of inertia!...

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